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Computer Graphics Models of Human Faces

Generating realistic models of human faces is not an easy task in computer graphics. There are many different features to consider, including face shape, wrinkles, pores, and distance between facial features. Human brains are subconsciously very aware of the proper configuration of a human face. Therefore, any small abnormality in the model is very obvious to humans. This is why so much effort and detail needs to be put into creating realistic models of human faces. What complicates things further is that models of faces in movies and video games are not stationary. The characters talk, move and show emotion. Animators and artists need to be able to take models of faces and make them move, all while making them look realistic and genuine. [1, 2]

Over the years, there have been multiple different techniques to create models of human faces. Many of these methods date back to the early 1990's. The two papers I read have very different approaches to accomplishing this. First, the methods described in the paper, "Blending Face Details: Synthesizing a Face Using Multiscale Face Models" use an approach that creates composite faces by blending multiple different models. This paper makes reference to another paper in the field, "Multi-Scale Capture of Facial Geometry and Motion". This paper creates representations of facial wrinkles and shape using specialized arrays of cameras and video cameras, to capture a real human face. These two papers present two greatly different approaches to accomplish a similar task.

The older of the two papers, “Multi-Scale Capture of Facial Geometry and Motion”, was published in 2007 in the *ACM Transactions on Graphics* journal. The method the researchers used to capture facial models was a multi-step process. This method requires an actor to have their face captured by the computers. First, a static model of the face is captured using a specialized face scanning system. Next the movement of the face is captured using a specialized array of at least six high-definition cameras. These cameras are strategically placed so that each point on the face can be seen in at least two different cameras. The cameras that are used are carefully configured to use specific framerates and resolutions so thee different results can be combined together easily to form a complete model. Some of the cameras are recording faster than the others, in order to capture the small-scale face motions and the large-scale motions separately. Throughout this process, the actor must have dots painted all over their face. These dots are used later by the algorithm to analyze how different parts of the face move. Before the static models and the video models can be combined together, any visible wrinkles that are on the actor must be removed from the static model that was captured. If they are not removed, when the digital model is synthesized by combining the static and video captures, the wrinkles will be amplified. The limitation of this method is that it can only be used to play back pre-recorded motion. It cannot be used to create an animation of an actor making arbitrary movements. [2]

This paper, however, really shows its age when you look at it closely. The related work that this paper references is all from the early 2000’s and late 1990’s. In a field that is changing so fast, I believe that a lot of this work is very outdated in 2018. In addition, in images included in the paper, CRT monitors along with large, white CPU towers.

Equipment like this is rarely used today. Lastly, the machine they used for their calculations had only 1 GByte of main memory. This is much lower than the standard for even low-cost computers nowadays.

The other paper, "Blending Face Details: Synthesizing a Face Using Multiscale Face Models", published in *IEEE Computer Graphics and Applications* in 2017 takes a different approach to solving the same problem described in the previous paper. This method utilizes the combination and blending of multiple face models into one. This method is very dynamic, because it allows for artists to choose what features to weigh more than others. These features could include wrinkles, face shape and pore size. For example, the wrinkles of one base model could be weighed more heavily than the shape of the face in another base model. These two models would then be combined algorithmically by blending them together to produce a new model that is a combination of the other models. This paper references the limitations of previous ways of performing this task, and specifically speaks about the restrictions of the method outlined in the previous paper I described. The benefit of this new technique is that no specialized image capture hardware is required to capture human faces to create baseline models. The base models can be sculptures that artists create, or images of real people. This means that artists are not restricted to capturing face models that require specialized hardware. [1]

With this method, the base face models do not need to be human either. The base models can be anything, including animals, aliens, and monsters. This is necessary in the case of werewolves, for example. Artists are able to combine the facial model of a human face and a non-human face into one complete model. This is possible because the initial models can be artist created sculptures. The models that are generated from this technique

can be animated, unlike those models in the other paper. Since no video recording is done, the animation is the only way to generate face models that move. [1]

Unlike the first paper, this paper is clearly much more modern. This is visible from the graphics and visuals included in the paper. The graphics are very detailed, and clearly on a higher level than those included in the earlier paper. Additionally, the computers they used to do their computations are much newer. They utilized machines with 4 GBytes of main memory and dedicated graphics cards.

Both the papers, "Multi-Scale Capture of Facial Geometry and Motion", published in 2007 and "Blending Face Details: Synthesizing a Face Using Multiscale Face Models", published in 2017, clearly had impact in the field of computer graphics facial modeling. The first demonstrated a method of capturing models of human faces and wrinkles based on images and videos of human actors. These models that are generated cannot be animated, they can only be played back. The second paper built on this principle by allowing models to be generated dynamically by combining multiple different face models, without the need for specialized hardware. Although the newer paper is clearly more sophisticated by today's standards, without the work done by the researches in the earlier paper, the modern work would not be possible.

References

[1] Bernd Bickel, Mario Botsch, Roland Angst, Wojciech Matusik, Miguel Otaduy, Hanspeter Pfister, and Markus Gross. Multi-scale capture of facial geometry and motion. *ACM Trans. Graph.*, 26(3), July 2007.

[2] S. H. Yoon, J. Lewis, and T. Rhee. Blending face details: Synthesizing a face using multiscale face models. *IEEE Computer Graphics and Applications*, 37(6):65–75, November 2017.