CONSTRUCTION AND PERCEPTUAL EVALUATION OF A 3D HEAD MODEL

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Abstract

This paper presents a method to construct a compact 3D head model capable of synthesizing realistic face expressions with subtle details such as wrinkles and muscle folds. The model is assessed by Psychologists using the certified FACS coding method. Such a compact and accurate model offers a large market potential not only in Computer Graphics industries but also in low-bandwidth applications e.g. tele-conferencing, and provides a valuable novel tool for Perceptual Studies.

1 Method and Implementation

The method used to construct the 3D head model in this work is inspired from the 2D Active Appearance Model described in [1]. Such a data-driven approach is able to synthesize highly realistic face expressions since the model is trained from real video sequences. Although a number of previous researches already employed similar techniques, they built the PCA model using only the landmarks placed on key facial features e.g. lip corners, eye corners and are unable to reproduce fine details such as wrinkles and muscle folds. Our approach consists of first using a warping technique to bring all the raw video frames into correspondence (i.e. we force all the 3D meshes in the video sequence to have the same number of vertices) and then build the PCA model using all vertices. This improvement allows to synthesize accurate skin deformations and thus, increasing the degree of realism.

Besides, a synthesized face looks more authentic if not only it appears like a human, but also moves like a human. Therefore, it is very important to accurately model the dynamics of the facial expressions. Not many researches have achieved this task so far in 3D animation, which is mostly due to the limitations of their data capture equipments. In this research, we use a fast 3D video camera (48fps) to capture our training data, which allows to model a fine temporal dynamic of the face movements.

Finally, we combine the method described above with FACS coding to further improve the precision of our head model. FACS is a certified method used in Psychology to study facial movements [2]. It consists of describing a face expression as a combination of Action Units (AU), each AU is the smallest observable facial change corresponding to the action of one or more muscles. FACS provides two main contributions: the anatomical foundation allows to validate the consistency of the synthesized muscle deformations, and the psychology aspect allows to assess the authenticity of the face expression.

2 Results

Our training data consists of short video sequences of Action Units (about 60 frames each). After building a joint PCA model of shape and texture, we obtain a set of Eigenvectors which represent the different modes of variations of the facial changes. Figure 1 shows snapshots of a neutral face and a 'disgust' expression which have been synthesized using our PCA model.

Figure 1: Expression 'disgust' synthesized using our 3D head model and validated by Psychologists using FACS coding.

Typically between 80% and 90% of the energy is contained in the highest Eigenvalue and therefore, the AUs can be accurately synthesized by altering only one single control parameter. Figure 2 shows snapshots taken from a video sequence of an expression 'disgust' synthesized with our 3D model, together with the temporal variation of the principal control parameter.
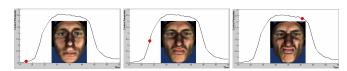

Figure 2: Dynamic of the expression 'disgust' synthesized by varying only the principal control parameter.

3 Conclusion

We have successfully built a 3D head model capable of synthesizing realistic-looking face expressions, reproducing accurate skin folds and expression dynamics. We plan to use this model to study and model facial idiosyncrasies.

References

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