A FACS Validated 3D Human Facial Model

Darren Cosker *
Department of Computer Science
University of Bath

Eva Krumhuber†
Swiss Center for Affective Sciences
University of Geneva

Adrian Hilton‡
Center for Vision, Speech and Signal Processing
University of Surrey

Abstract

The Facial Action Coding System (FACS) [Ekman et al. 2002] has become a popular reference for creating fully controllable facial models that allow the manipulation of single actions or so-called Action Units (AUs). For example, realistic 3D models based on FACS have been used for investigating the perceptual effects of moving faces, and for character expression mapping in recent movies. However, since none of the facial actions (AUs) in these models are validated by FACS experts it is unclear how valid the model would be in situations where the accurate production of an AU is essential [Krumhuber and Tamarit 2010]. Moreover, previous work has employed motion capture data representing only sparse 3D facial positions which does not include dense surface deformation detail.

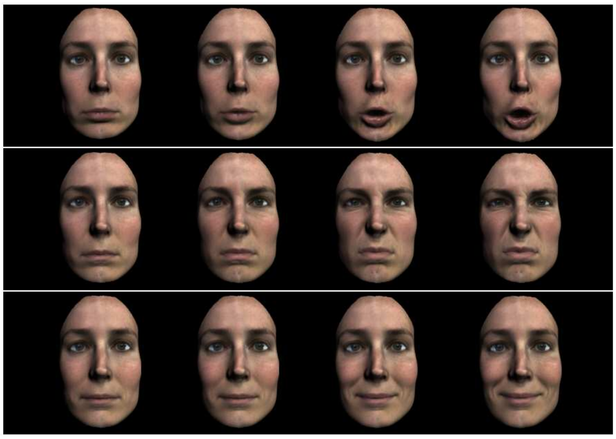

Figure 1: *Examples: AU 22 (top), AU 9 and AU 12 (bottom)*

Our Approach

In this work, we present the first Facial Action Coding System (FACS) valid model to be based on dynamic 3D scans of human faces for use in graphics, animation and psychological research. The data set used to train the model is recorded from an individual performing a range of different AUs. Unlike previous work using FACS, we employ certified FACS coders to ensure that AUs performed in our captured data are valid representations. This makes the model fully reliable and valid for psychophysical experimentation. We also capture the AU movements using real-time stereo 3D capture technology, and create facial parameters that produce realistic non-linear movements when being manipulated. That is, as the intensity of a parameter gets increased, the surface and texture of the facial model moves and transforms in a highly realistic manner. The underlying model is akin to a 3D morphable model [Blanz and Vetter 1999]. However, due to the real time nature of the scanning device, statistical information is available for the full dynamic evolution of each expression both in terms of its geometric and temporal information.

Data Capture Facial poses recorded from a FACS expert were used for building our model. In total, 20 upper and lower face AUs (i.e., AU1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 23, 24 ,25) were displayed and verified. FACS validation of our recorded data and of the output of our animation model was performed blindly using two independent FACS coders. Our acquisition device consisted of a 3DMD active stereo 3D capture system. This uses a projected infra-red speckle pattern to calculate stereo correspondence and produce 3D surface reconstructions. The system has a capture rate of 60Hz, and therefore provides smooth temporal acquisition of fast facial movements.

Dynamic 3D Facial Modeling We have developed a pipeline that creates a highly detailed statistical 3D facial model from our acquired raw 3D surface and UV map data. We first apply a denoising filter to the 3D sequence in order to remove surface noise. We then create cylindrically unwrapped UV maps for each sequence. We select a single mesh from a neutral facial pose to act as our canonical mesh, i.e. a mesh with a known vertex number and topology. We then select a set of 54 landmarks on the canonical UV map relating to features such as mouth and eye corners and freckles. We next use a point tracker utilizing phase-based optical flow to track similar landmark positions through the UV sequences for each AU. Using correspondences from our tracked points we next align each UV map with the canonical UV map. This process is repeated for each scan in each AU sequence, resulting in the entire data sequence having the same topology and number of vertices. We then build a Morphable Model from this data [Blanz and Vetter 1999] which allows animation of the model and playback of recorded movements using compressed parameters (see Figure 1).

Conclusion

The validation results of the 20 captured AUs as performed on the output of the animation model showed that the AUs achieved verification by the FACS coders. Note that matching AU target and validation codings indicate that the animation modeling pipeline is faithfully preserving the AU and not corrupting its representation.

References

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*e-mail:dpc@cs.bath.ac.uk
†e-mail:Eva.Krumhuber@unige.ch
‡e-mail:A.Hilton@surrey.ac.uk