

MonkeyHead: Highly-Realistic Computer-Animation Model for Macaque Facial Expressions

Nick Taubert¹, Akshay Markanday¹, Silvia Spadacenta¹, Peter Dicke¹, Peter Thier¹ & Martin A. Giese¹

¹Section Computational Sensomotrics, Department of Cognitive Neurology, University Clinic Tübingen, Centre for Integrative Neuroscience, Germany

Although facial expressions are generically dynamic most emotion research has focused on static faces, in humans as well as in non-human primates. The reason for this is the difficulty of the exact control of the relevant stimulus features in dynamic facial expressions. As an important step towards controlled electrophysiological experiments on the neural encoding of dynamic monkey facial expressions, we have developed a computer animation model that realizes highly-realistic facial expressions of macaques, which allows to realize such expressions in real-time. Based on an MRI scan, a 3D model of a monkey head was designed. This model was equipped with a muscle-like system of ribbons in order to control the motion of the surface elements of the face. The facial motion was derived by motion capture (VICON) from real monkey expression, using 43 reflective markers, where the animal was motivated by an experimenter to realize three facial expressions. In order to obtain a high degree of realism with real-time animation, diffuse textures and textures with high frequency details were extracted from photographs that were nonlinearly aligned with the head scan. These details were then added as maps to a version of the monkey head with a relatively low number of polygons. In addition, we developed a physics-based real-time shader with a bidirectional reflectance distribution function (BRDF) as reflection model. This shader was applied to model subsurface-scattering to mimic translucent properties of the skin: Furthermore, we introduced a real-time hair simulation with physically accurate behavior. Face expressions are generated by a dynamical extension of Gaussian Process Latent Variable Model (GPLVM) with additional style control [1,2]. It is demonstrated that the model generates multiple highly-realistic monkey facial expressions, using DirectX framework as rendering environment.

[1] Taubert, N., Endres, D., Christensen, A., & Giese, M. A. (2011, October). Shaking hands in latent space. In *Annual Conference on Artificial Intelligence* (pp. 330-334). Springer.

[2] Taubert, N., Christensen, A., Endres, D., & Giese, M. A. (2012, August). Online simulation of emotional interactive behaviors with hierarchical Gaussian process dynamical models. In *Proceedings of the ACM Symposium on Applied Perception* (pp. 25-32). ACM.