

# Mathematical Models for Computer Facial Animation

*Ken Anjyo*  
*OLM Digital, Japan*

Computer facial animation plays a crucial role in digital storytelling, including films, video games and web content. In a digital production workplace, mathematical tools are then indispensable to achieve efficient production of high quality facial animation. This talk describes the common practices and techniques in facial animation and their mathematical background. More specifically we discuss:

- *Deformation Techniques:* Muscle deformation need to be considered not only for face, but also for whole body animation. We explain and demonstrate a few techniques, such as SSD (skeleton subsurface deformation) and PSD (pose space deformation), which help the artists to make plausible muscle deformation during animation.
- *Blendshape Facial Animation:* Blendshapes are a standard approach in making facial animation. Each face model is then considered as a vector of all vertices on the face. As a prerequisite, several typical face models, such as light-eye blink, smile, disgust, etc., are made in advance. These typical faces are called target faces and then a general face model is represented as a weighted linear sum of the target faces. The face model is thus animated by changing the weights over time. Fine-tuning of the weights is then required and becomes a laborious task, if the number of target faces is quite large. We address a few but important issues in the blendshape facial animation. For example we show a direct manipulation method that avoids the laborious weight-tuning task.
- *Applications:* We illustrate how the above techniques are applied in the creation of facial animation. For example, it is shown that lip-synch animation can be made using the blendshape techniques. Our ongoing approach of integrating lip-synch process with facial expression creation will also be demonstrated.

In addition we talk over what kinds of mathematical techniques or concepts should be explored next for better understanding and more efficient creation of facial animation.