Nowadays virtual humans fulfill many roles, such as newsreader, assistant to help in the use of complex systems, teacher, characters in virtual worlds, computer games or films. The face of these virtual humans should be as expressive as the real human face. It should be unique, move in accordance with speech, should reflect emotions, cognitive and biological state. The most often used technology is face tracking: a real person’s face controls the motion of a synthetic one. This method requires expensive equipments and software, and on the other hand, it is difficult to reuse the tracked motion, especially for interactive applications.

In the light of the current state of technology, it was a novel and up-to-date task to develop a facial animation paradigm, which:

- allows the animation of different (2D/3D, controlled by different parameters) faces;
- supports the re-use of tracked motion;
- makes it possible to build and re-use a facial repertoire library;
- serves as basis to create automatic lip-sync;
- next to the parameter-based (extensional) manipulation, allows the conceptual (intensional) definition of dynamical expressions;
- helps the animator to create an animation which meets the requirements set on a high, conceptual level.

The topic of the Ph.D. thesis is a facial animation representation and manipulation scheme with the above functionalities.

1. I developed two paradigms to explore the multi-dimensional expression space ([A], [J], [M], [0]).
2. I gave a model-independent, parametric representation of facial animations, which is suitable to define static as well as dynamic facial expressions, and also complete animations, made of scratch or gained by motion tracking ([E], [F], [G]).
3. I showed that it is possible to use constraints to define dynamical expressions and animations intensionally ([D]). This is an entirely new approach which unlike traditional curve manipulation, provides a basis to design facial behavior and expression repertoire. I prove that the general method of interval propagation, coupled with a flexible search strategy, is suitable to help the user in the interactive development of an animation which fulfills pre-set requirements ([H], [C]).
4. I gave a method to generate lip-sync automatically, in different quality, independent of the language to be spoken and the synthesizer used ([K]).

The above results served the basis to implement a modular facial animation system ([I], [N]). The tools have been used, among others, by researchers at the University Roma ‘La Sapienza’, Vrije Universiteit Amsterdam and the Katholijke Universiteit Brabant to animate a 3D realistic head and VR avatars, and to investigate the phenomena of visual speech. The Dutch EPICTOID B.V. is going to market the sw, developed on the basis of the results of my research.
List of own publications related to the Ph. D. work

Most of the articles, and some demos can be downloaded from  www.cwi.nl/CharToon  and www.cwi.nl/~zs/sofi/publist.html web pages.


