Facial Animation by the Manipulation of a Few Control Points Subject to Muscle Constraints

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1. Introduction

Muscle-based Facial Animation

- One of the best approaches to **realizing a realistic, lifelike character**.
- However, the optimal control of each muscle to generate facial animation is complicated.

The goal of our work is…

- To synthesize realistic facial animation with a variety of facial expressions by **automatically estimating facial muscle parameters through the manipulation of only a few control points on the face**.
- To develop a facial expression cloning method that transfers an actor's muscle parameters to another character.

Y. Lee, D. Terzopoulos, K. Waters, Realistic modeling for facial animation, Proc. SIGGRAPH 95, 1995, 55-62.
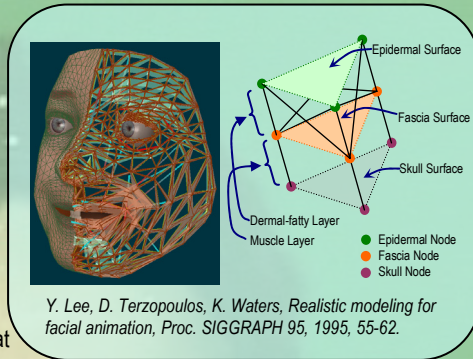
2. Facial Measurement and Modeling

Constructing Actor's Facial Model:

- Scanning the subject using a 3D scanner. (Cyberware 3030 RGB)
- Adapting a generic face mesh to the acquired facial data.
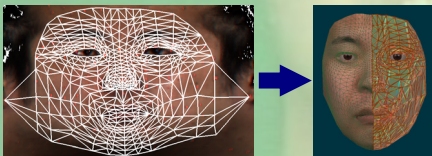
Motion capturing:

10 Motion Capture Cameras (VICON MX-40)

The motion of each marker on the actor's face while he creates various facial expressions is recorded at 120 fps.

3. Facial Muscle Parameter Estimation

Surface Error (SE) Minimization:

The simulated facial model:
Uniquely determined by 37 facial muscle parameters.

To find the optimal facial muscle parameters:
Minimize the difference between the surface of the actor's face and that of the simulated face – **Surface Error** .

Total of Control Points:
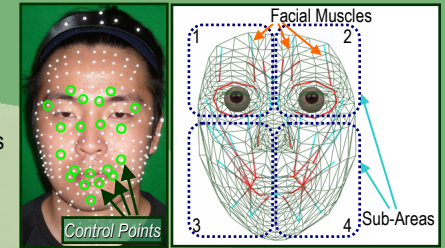**20 motion capture markers**.

Separating the Face Area into 4 Sub-Areas:

The facial muscle parameters:
Too numerous to easily solve this problem.
Therefore –
The facial surface is divided into 4 sub-areas.

$$E_k\left(\mathbf{p}^k\right) \equiv \sum_{i=1}^{n_k}\left|\ \mathbf{x}_{r,i}^k - \mathbf{x}_{s,i}^k\left(\mathbf{p}^k\right)\right|$$

$$\mathbf{p}_{optimal}^k = \underset{\mathbf{p}^k}{\arg\min}\left(E_k\left(\mathbf{p}^k\right)\right)$$

E_k Surface error (SE) of Sub-Area k

$\mathbf{p}^k$ Muscle contraction parameters

n_k Total control points of Sub-Area k

$\mathbf{x}_{r,i}^k$ Positions of the real control point i

$\mathbf{x}_{s,i}^k$ Positions of the simulated control point i

4. Facial Animation Synthesis Results

Muscle contraction → Animation of actor's model:
Estimated by minimizing the SE, according to the movement of the **20 motion capture markers**.

Muscle Parameters Estimated

Muscle Parameters Applied

(a): Actor's expression. (b): Actor's facial model with automatically estimated muscle parameters. (c): Facial model of another character with the muscle parameters of (b) applied.

5. Conclusion

- We proposed the automatic synthesis of facial expression by manipulating a few control points under facial muscle constraints.
- We have been able to synthesize facial expressions easily by adapting generic facial muscle parameters to any characters' facial model only by fitting a generic model to personal data.

6. Acknowledgement