Animation & Simulation

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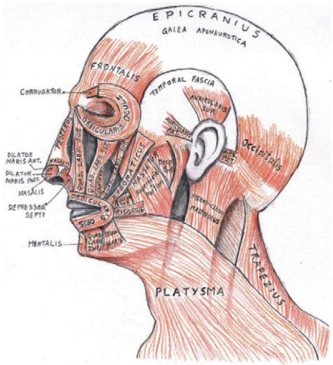
Facial Animation

- Very difficult but necessary
  - A single mechanical articulator but an extremely flexible covering
  - Important for communication: mood, personality, etc.
  - Speech: lip movements
  - Accurate timing needed
- Human Face
  - Anatomy

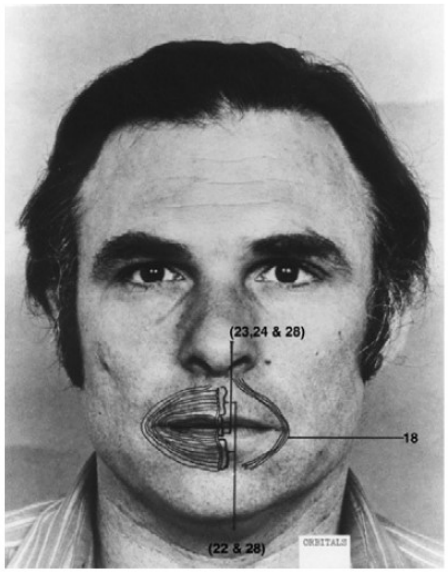


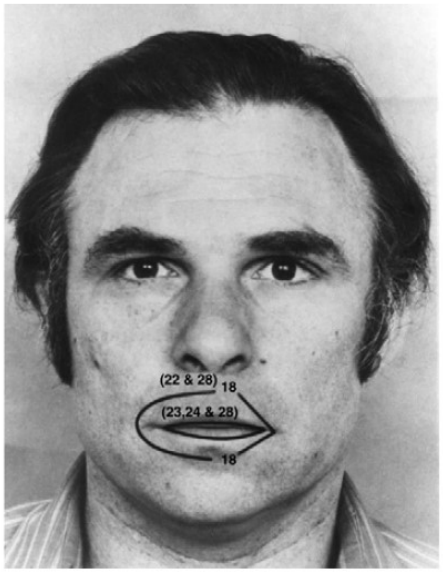
Muscles

Muscles that significant in facial expressions

Facial Animation

- Human face
  - The facial action coding system (FACS)
    - Deconstructing facial expressions to basic movements, called action units (AUs) (Ekman & Friesen, Consulting Psychologists Press 1978)
    - 46 AUs are studied
    - Weighted blending can work
      - No motions, just static expressions
      - No timings





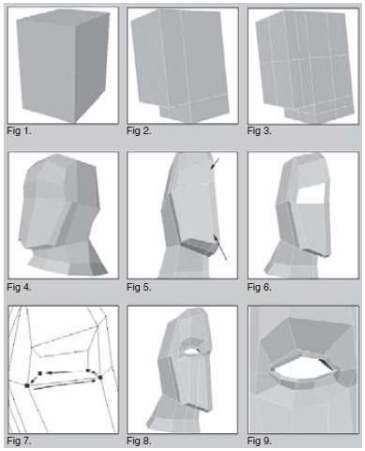
Facial Animation

- Human face
  - The facial models
    - Face geometry->modelling, capture, generated
      - Polygonal, Spline models, Hierarchical spline models.
      - Creating a continuous surface
        - Interactive system to hand-craft a face
    - Deformation->hand-crafted, computed
    - Control

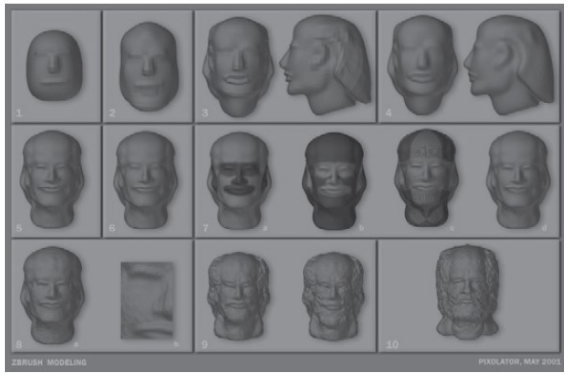
Facial Animation

- Human face
  - The facial models
    - Creating a continuous surface
      - Interactive system to hand-craft a face

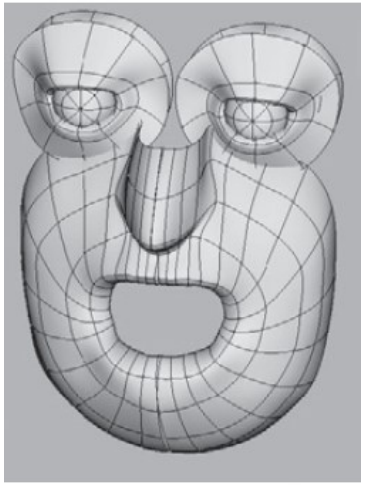
Refining a low-res mesh



Modify a high-res simple shape

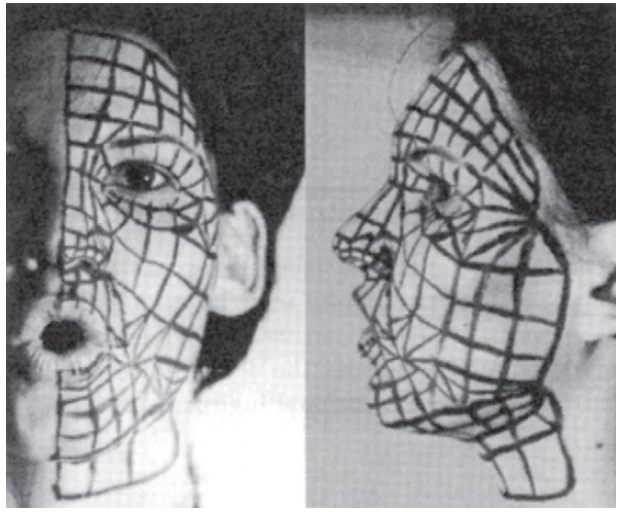


Design it from high-res areas



Facial Animation

- Human face
  - The facial models
    - Creating a continuous surface
      - Digitalising with physical references
        - Physical sculpture->mechanical/magnetic digitaliser
          - Can be cheap but requires artistic talent
        - Laser scanner
          - Expensive, bulky
      - From photos



Facial Animation

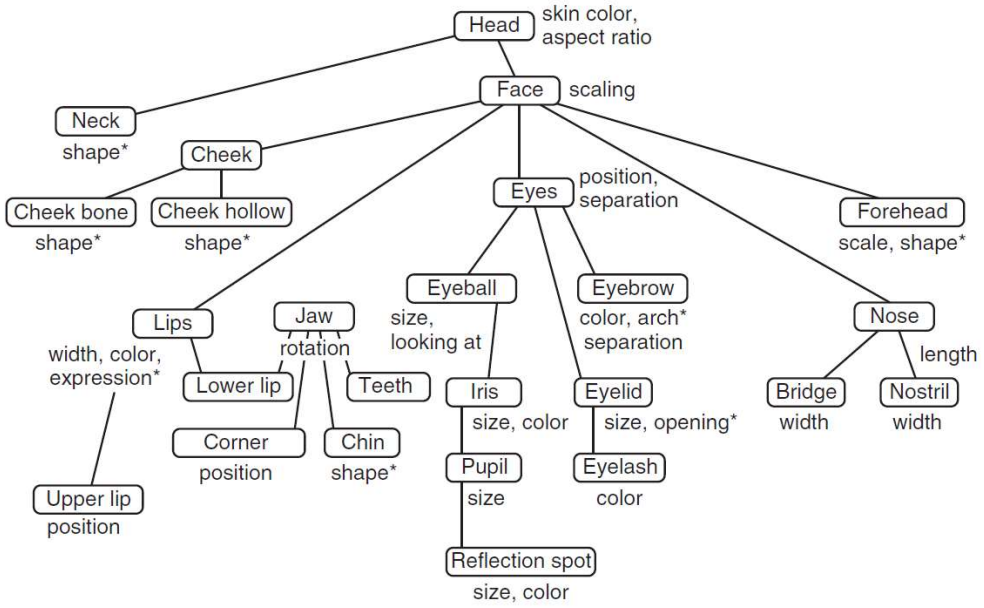
- Human face
  - The facial models
    - Creating a continuous surface
      - Modifying existing models
        - Parameterised template faces
          - Parke model:
            - conformational parameters, distinguish faces
              - shape of the forehead, cheekbone, cheek hollow
              - scale distances between facial features, head x,y,z; chin to mouth and chin to eye; eye to forehead
            - Expressive parameters, to animate (discussed later)

Facial Animation

- Human face
  - The facial models
    - Textures
      - Very crucial
      - Capturing from real humans are possible but need pay attention to
        - Lighting conditions
        - Facial expressions
      - Laser scanner can directly get texture information

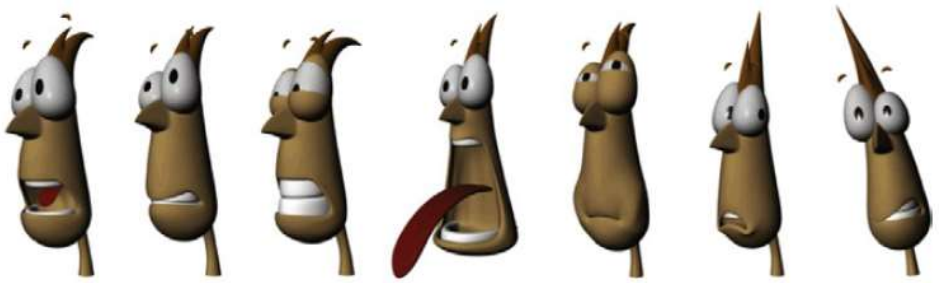
Facial Animation

- Animating faces
  - Parameterised models
    - Any plausible static face geometry is a n-dimensional point
    - If the data is dense enough, interpolation can be used



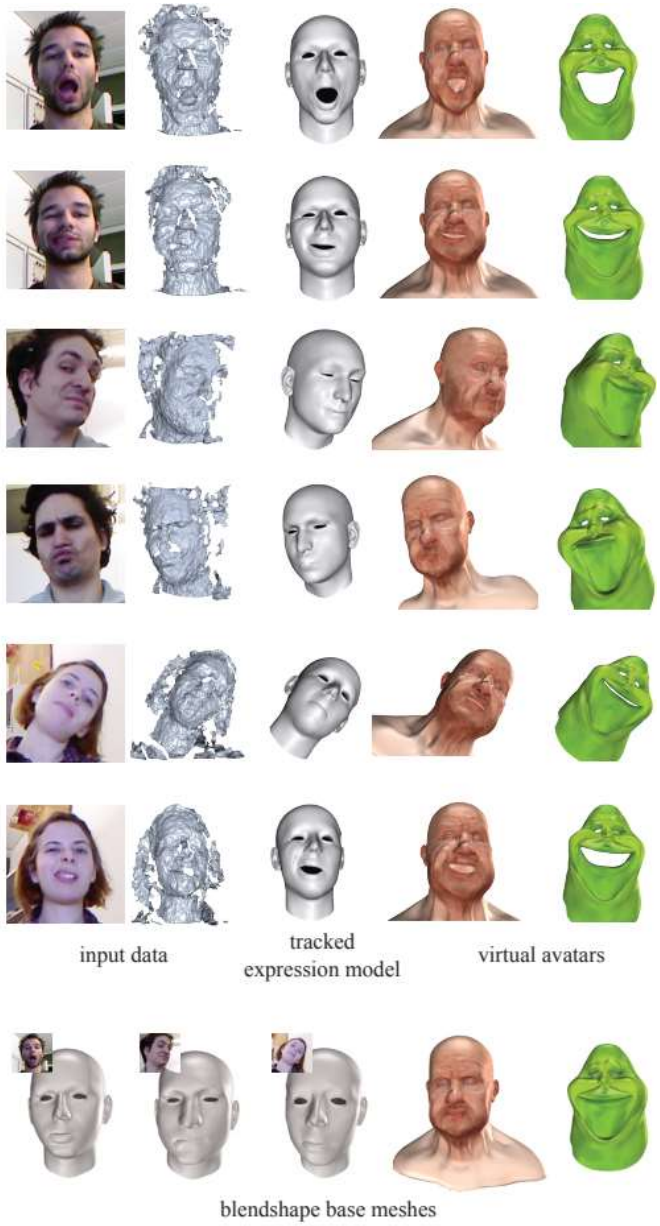
Facial Animation

- Animating faces
  - Blend shapes
    - The same topology, so consistent correspondences
    - Weighted linear/nonlinear combination of faces



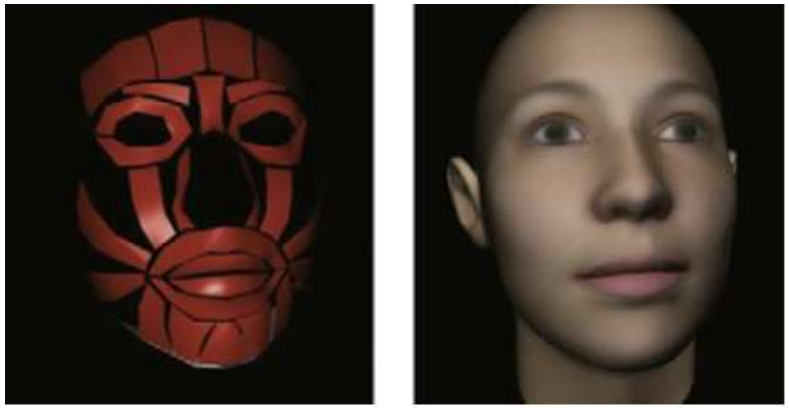
Facial Animation

- Animating faces
  - Blend shapes (Weise et al. Siggraph 2011)



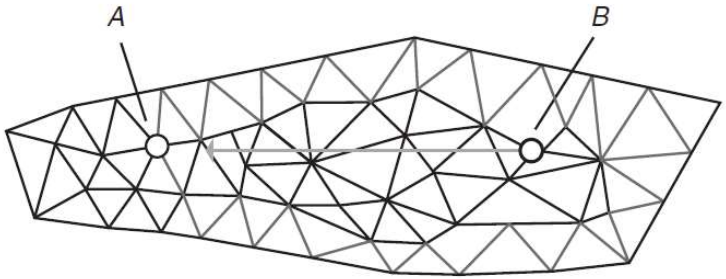
Facial Animation

- Animating faces
  - Muscle models
    - Explicitly model (simplified) muscles
      - Linear muscle (pull two points)
      - Sheet muscle (parallel arrays of linear muscles)
      - Sphincter muscle (contract a loop of muscles)

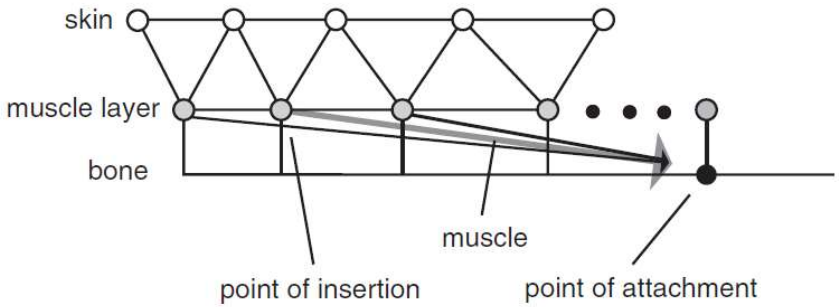


Facial Animation

- Animating faces
  - Muscle models
    - Explicitly model (simplified) muscles
      - Over the surface
        - Easier, just mesh deformation

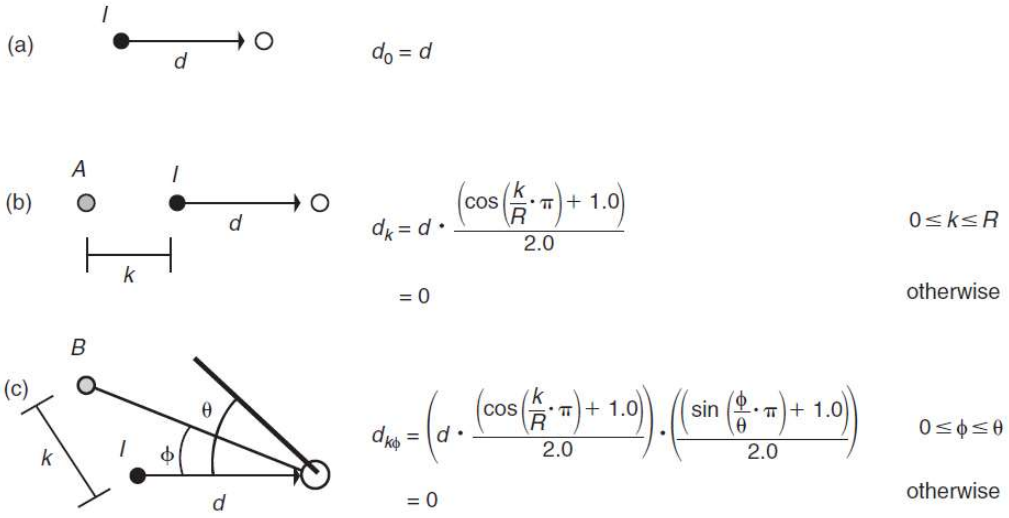


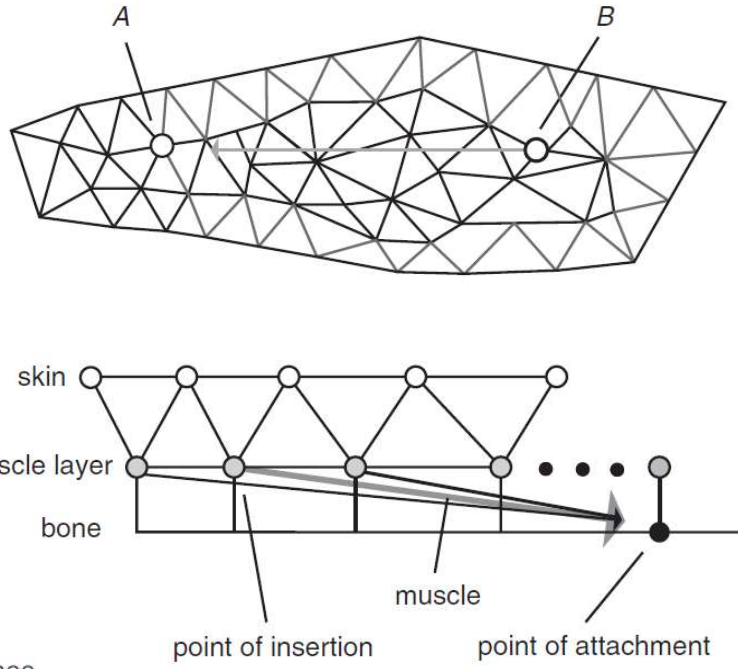
      - Attached to underlying structures (bones, tissues)
        - More accurate results but require more complex structures



Facial Animation

- Animating faces
  - Muscle models
    - Explicitly model (simplified) muscles
      - Attenuation

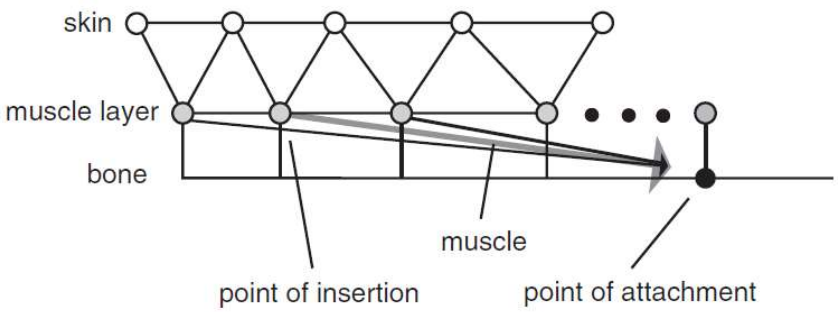


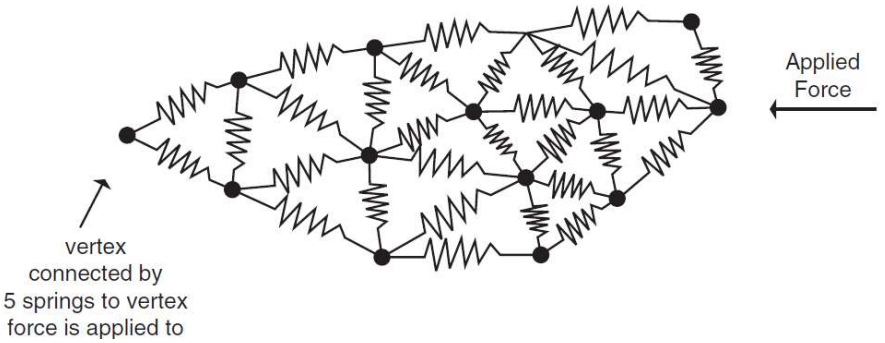


Sample attenuation: (a) insertion point *I* is moved *d* by muscle; (b) point *A* is moved d_k based on linear distance from the insertion point; and (c) point *B* is moved $d_k\phi$ based on the linear distance and the deviation from the insertion point displacement vector.

Facial Animation

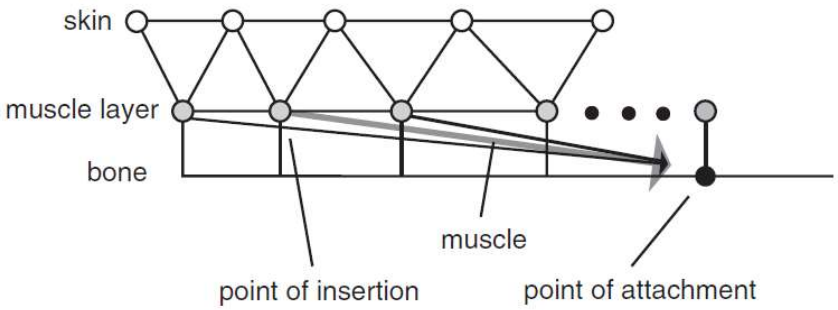
- Animating faces
  - Muscle models
    - Explicitly model (simplified) muscles
      - Attached to underlying structures (bones, tissues)
        - More accurate results but require more complex structures

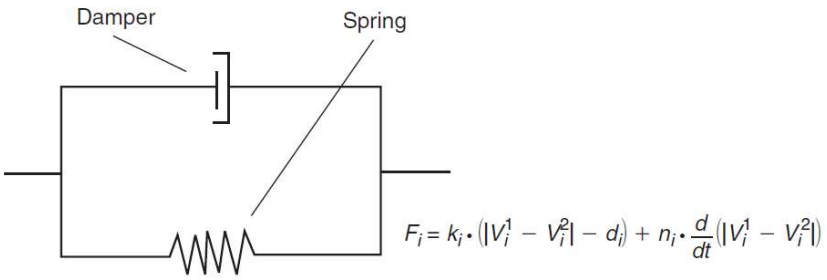




Facial Animation

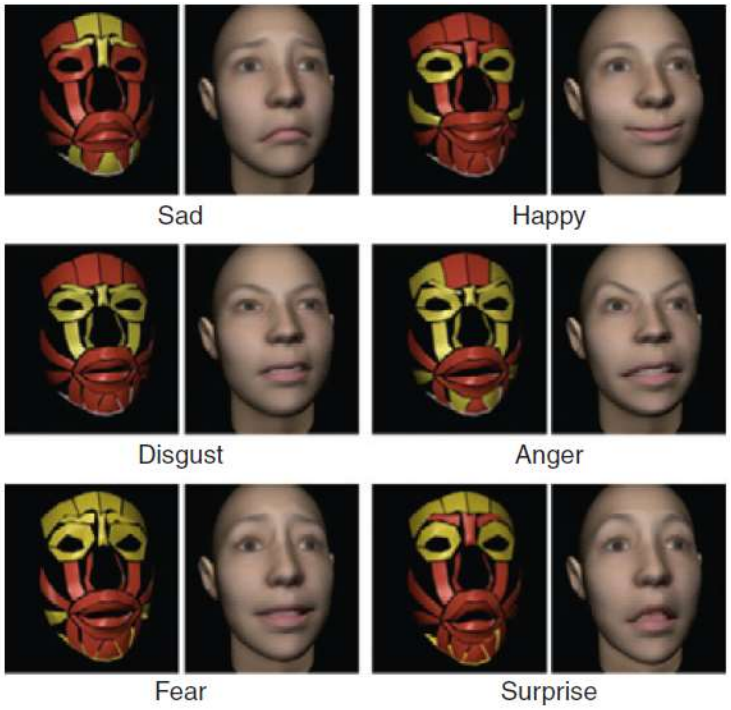
- Animating faces
  - Muscle models
    - Explicitly model (simplified) muscles
      - Attached to underlying structures (bones, tissues)
        - More accurate results but require more complex structures
        - Also slower and sometimes hard to control





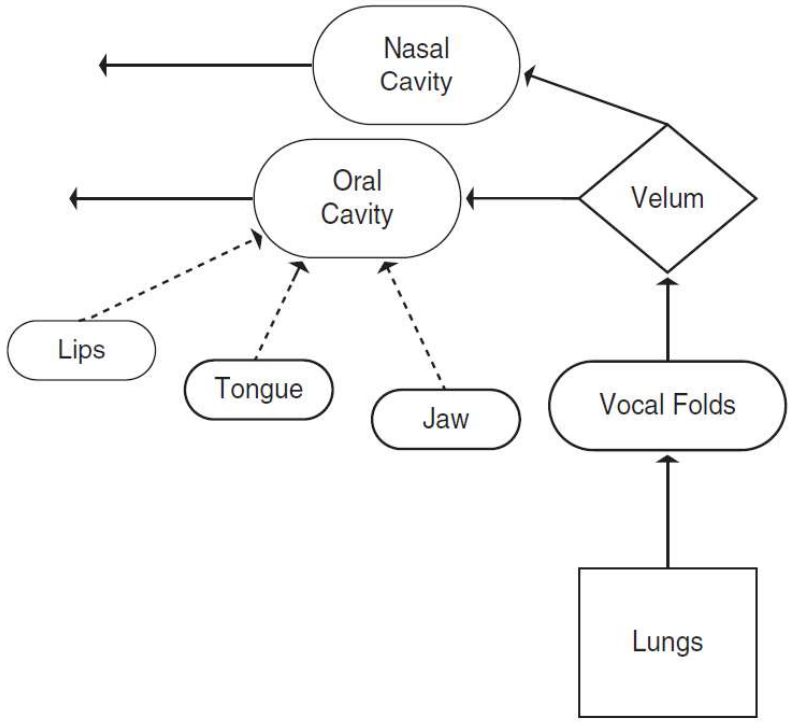
Facial Animation

- Animating faces
  - Expressions
    - Basic primitives



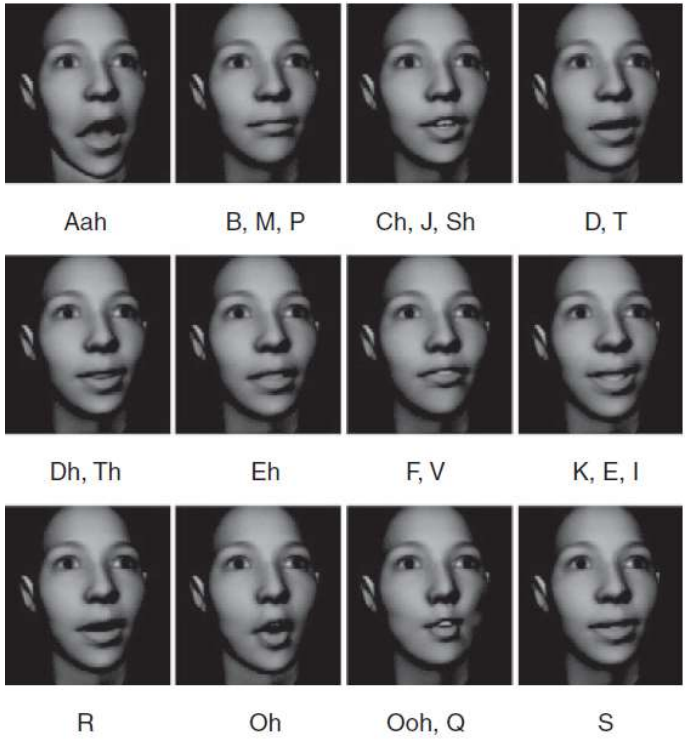
Facial Animation

- Animating faces
  - Lip-sync
    - Difficult in shape deformation
    - Difficult in sync with sounds
    - Articulators of speech
      - Cavity influences shapes



Facial Animation

- Animating faces
  - Lip-sync
    - Phonemes
      - Constituent, atomic sound segments

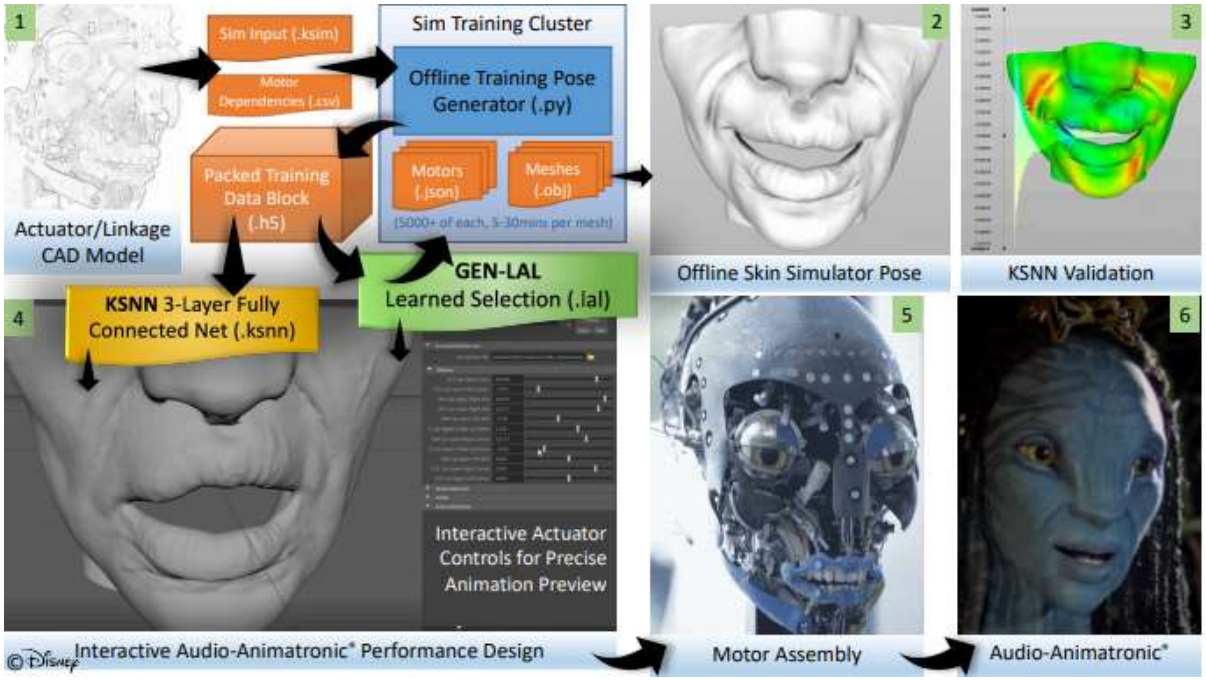


Facial Animation

- Animating faces
  - Lip-sync
    - Co-articulations
      - Adjacent phonemes affect the motion of the articulators
      - Blending adjacent phonemes
    - Prosody
      - Changing neutral speech to reflect emotional stress, or prosody.
      - Durations, pitch, amplitude
      - Units (words, phrases)
      - Open research

Facial Animation

- One recent paper



Castellon et al. Active Learning for Interactive Audio-Animatronic Performance Design, 2020