Facial Animation in H-Anim

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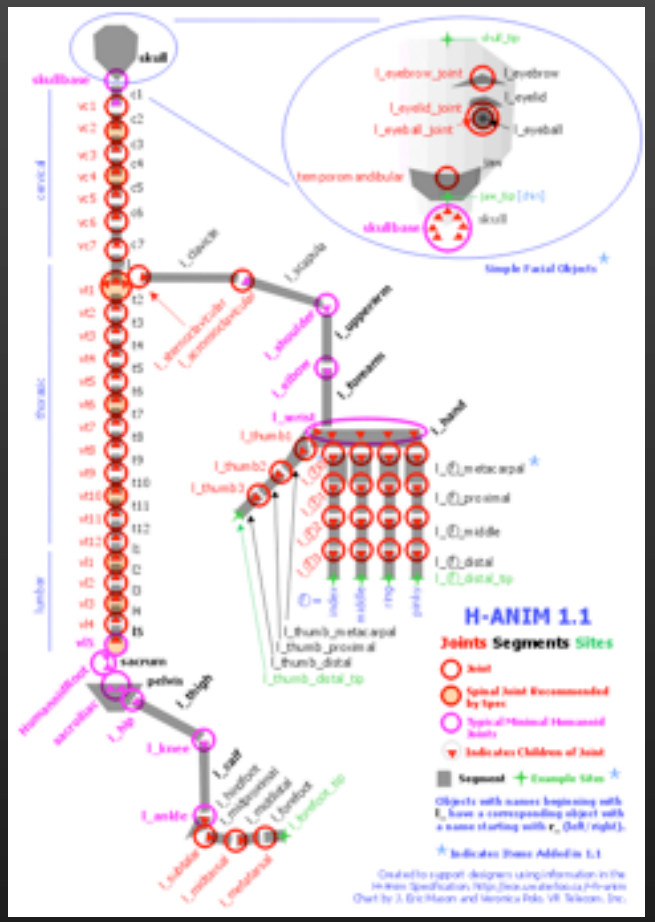
H-Anim: ISO/IEC 19774:2006

- H-Anim defines
  - The animation of a humanoid character
  - Joints and their relation
  - Motion by either
    - Keyframing,
    - Inverse Kinematics, and
    - Performance-based animation system
- H-Anim also represents
  - Facial animation
  - But not effectively or efficiently
- Objectives of this proposal
  - What to be defined to represent facial animation in H-Anim
  - Particularly for facial expression



The face in H-Anim (4.9.4)

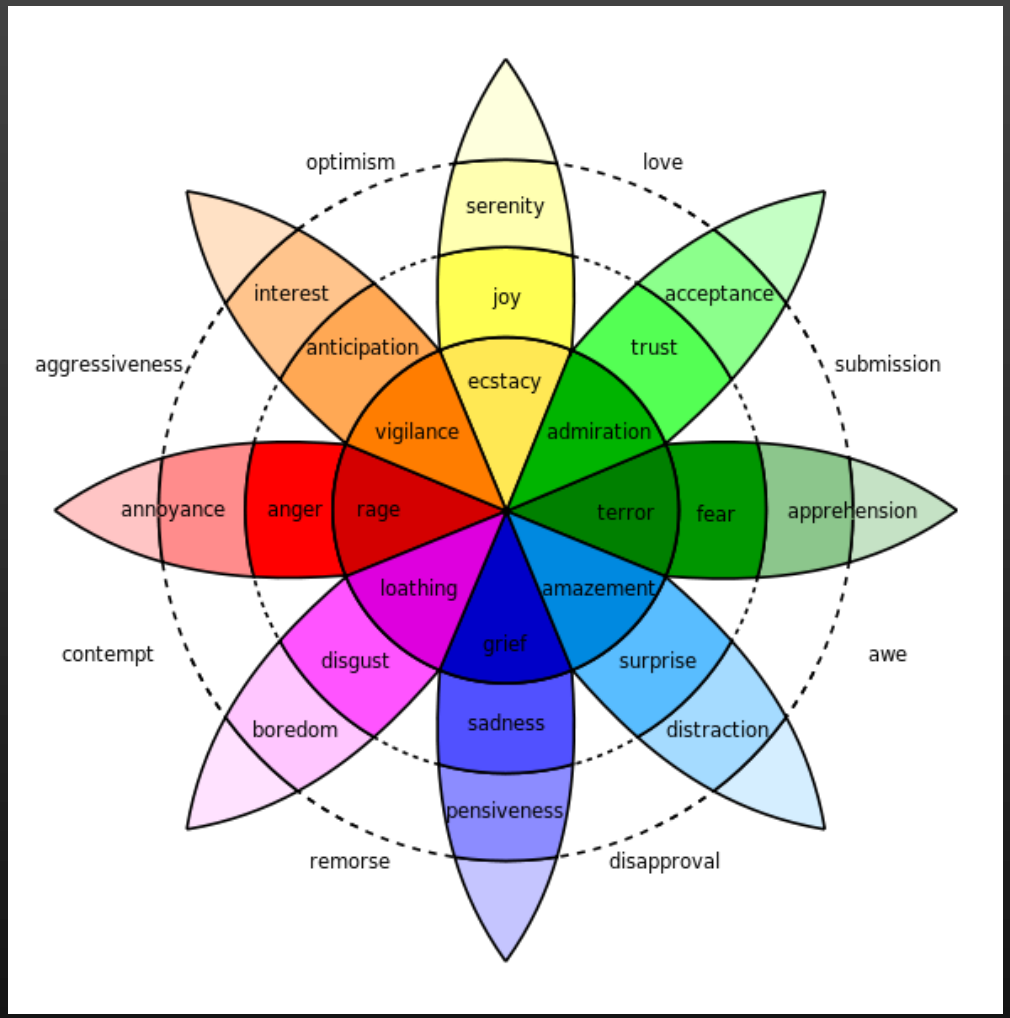
- There are seven "_joint"s rooted at skullbase
  - l_eyeball_joint and r_eyeball_joint : to change eye's gaze
  - l_eyebrow_joint and r_eyebrow_joint
  - l_eyelid_joint and r_eyelid_joint: to open/close eyes
  - temporomandibular : to open/close a mouth
- This can represent the facial animation of a ventriloquist's dummy
  - Facial animation without expression
- Facial animation with expression
  - Implemented by Displacer objects for face vertices
    - As Joe Williams pointed out in this January.
    - In case of a face, there might be a Displacer object for each facial expression (According to 4.7)

About facial expression

- Facial Action Coding System
  - Emotion consists of action units (AUs)
    - Happiness = 6+12, Sadness = 1+4+15, for e.g.
    - How many emotions?
      - <Plutchik's wheel of emotion>, for e.g.
    - How many AUs are defined in FACS?
      - 47 main codes such as "Inner brow raiser", "lip stretcher", and more
  - AU vs Displacer
    - Each AU can be defined by a Displacer object as in 6.6 such as
    - ```
      Displacer {
          coordIndex [7, 12, 21, 18]
          displacements [0 0.0025 0, 0 0.005 0, 0 0.0025 0, 0 0.001 0]
          name "l_eyebrow_raiser_action"
      }
      ```
    - Collecting a set of Displacer objects to represent a facial expression
      ```

About facial expression

- Plutchik's wheel of emotion



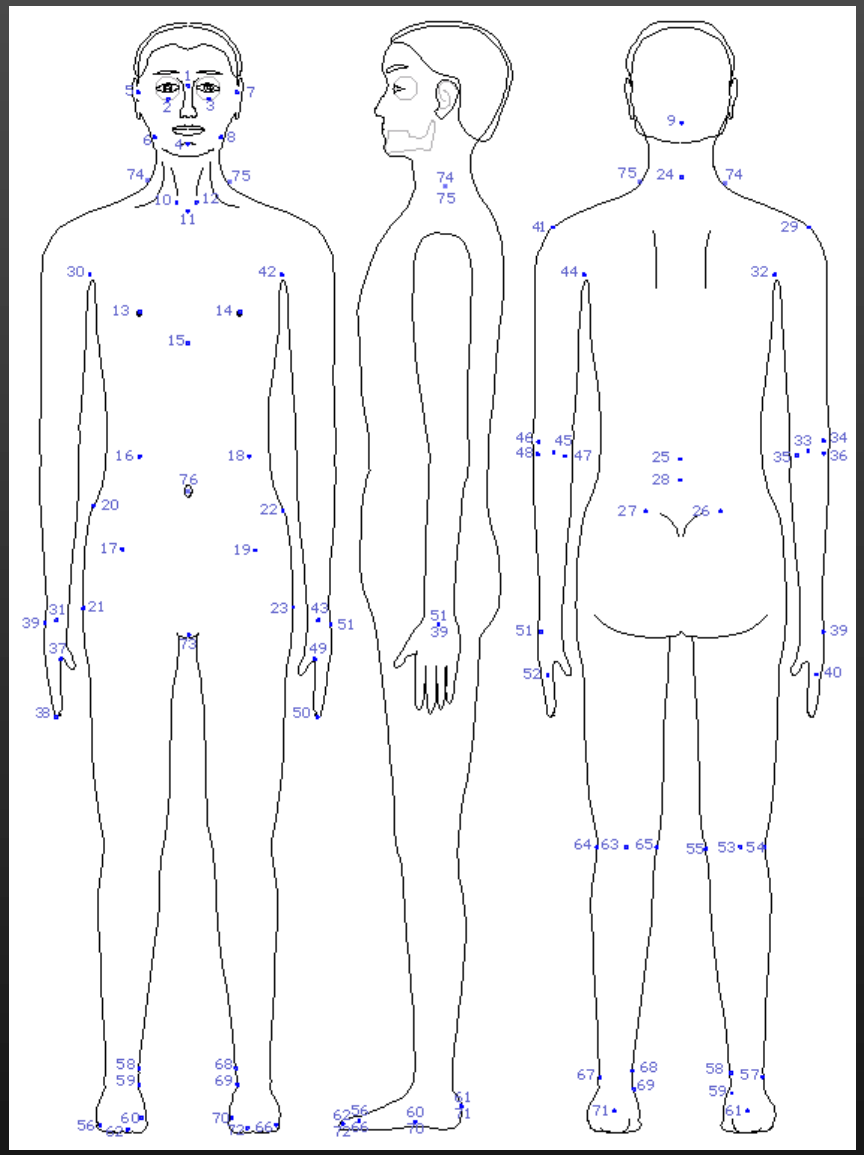
Conveying Emotion to H-Anim

- For each emotion, we can define a set of Displacer objects and/or joints angles
  - Joy, for e.g.
    - AU1 : inner brow raiser
    - AU2 : outer brow raiser
    - AU5 : upper lid raiser
    - AU12 : lip corner puller
    - AU20 : lip stretcher
    - AU25 : lips part
    - AU26 : jaw drop ← by temporomandibular joint angle
    - AU27 : mouth stretch

  - A displacer object defines which vertices to move
  - An action unit defines which features to move (or morph)

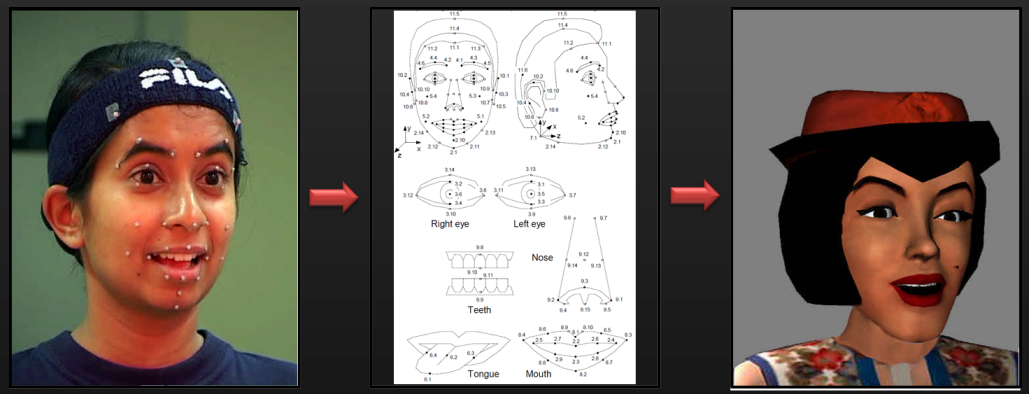
Features in H-Anim

- Only eight facial features in H-Anim
- For all 47 main AUs, more features on a face are probably required
- MPEG4 FPs?
  - 38 facial feature points(FPs) affected by FAPs excluding tongue and nose



Need to define new features?

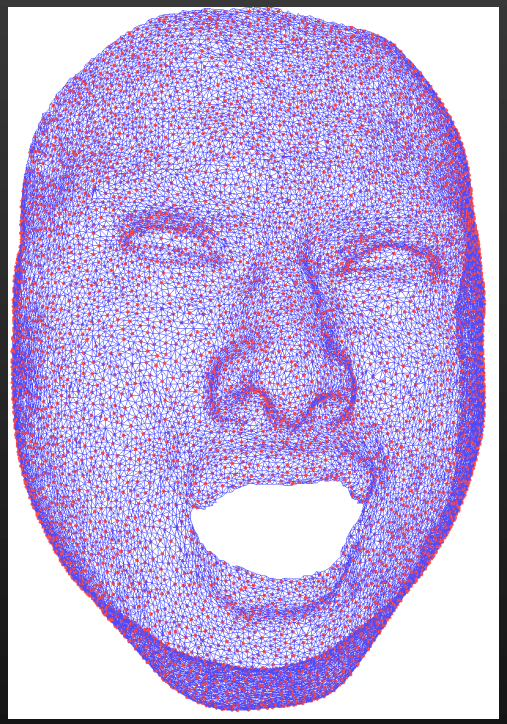
- Not necessary to define new features on a face.
  - Just use Displacer objects for some vertices to be considered as features
- If features are defined,
  - We can reuse facial animation to the other face models using the feature correspondences
  - When does this happen?
    - Making facial animation from facial capture system or unorganized facial vertex animation by large number of markers



Face capture | MPEG4 FAP | Synthesized face

Facial animation to H-Anim

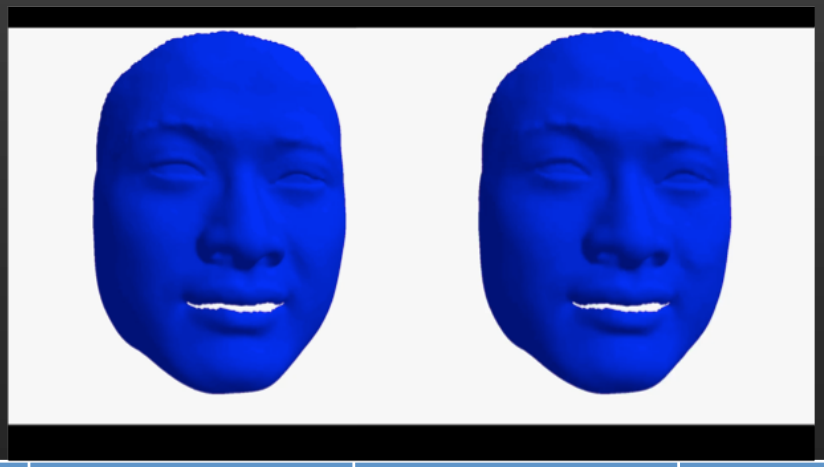
- Facial vertex animation
  - Define the motion of selected vertices using Displacers
    - How many vertices are to be selected?
  - Compute the motion of other vertices



23,728 vertices
Width: 163.035
Height: 214.229
Depth: 128.017

Facial animation to H-Anim

- Experimental result
  - Not using H-Anim Displacer objects with morph target, but simply preserving 3D mean value coordinates of the other vertices



# of vertices selected	15,641	12,058	10,965	7,956
RMSE	0.087	0.134	0.152	0.232
Max. Diff.	1.209	2.385	2.438	3.280

Facial animation to H-Anim

- Adequate to define several thousands of Displacers?
- Grouping vertices into a set of meaningful regions
  - It can be obtained from facial features, or we can define the regions as facial features.
  - Define a few displacer objects for each region
  - Parameterize the motion of region boundary from displacers
    - From existing example animation
  - Reconstruct the position of other vertices from region boundary

Facial animation to H-Anim

- Experimental result
  - 108 regions with 108 selected vertices (each of which corresponds to a displacer object in H-Anim)
  - Real data vs Reconstruction by selected vertices
    - RMSE 0.268910
  - Real data vs Reconstruction by real boundary
    - RMSE 0.268904
  - Reconstructions by selected vertices vs real boundary
    - RMSE 0.001516
- Selecting only a few tens of vertices is enough to represent facial animation with low error
  - Selected vertices are also good to represent another facial animation of the same model with RMSE 0.661022
  - In order to transfer the motion of selected vertices from one to the other face models, we need vertex correspondences

Conclusion

- Representing 3D facial animation in H-Anim
  - We can use displacer objects to represent facial expression
  - If facial features or their equivalent regions are defined, we can adopt facial vertex animation that are obtained from facial capture systems with large number of markers and we can transfer facial animation from one to another
- What I'm working on is
  - Exporting face vertex animation to H-Anim using Displacer objects
  - ~~Do we need to define facial expression (emotion) and its corresponding facial features?~~