Interpolating position

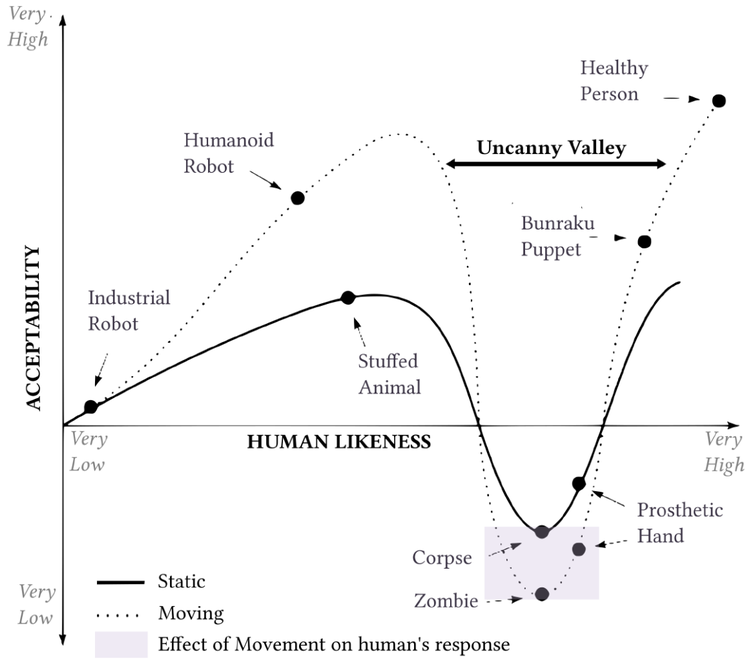
Facial Animation: Blend Shapes

Facial animation

Facial expression are particularily hard to automatically model

- Lots of details (huge number of muscles)
- Human perception is very sensible on face

  Risk of *Uncanny Valley*



Usage of keyframes interpolation

Facial expression are catgorized:

Interpolate every vertex between multiple meshes (key-poses)

Pose b_1 Interpolation $p(t)$ Pose b_2

$$p_i(t) = \omega_1(t) b_{i1} + \omega_2(t) b_{i2}$$

Blend Shapes: Multi-target blending

Interpolate between multiple key poses

Interesting for facial animation

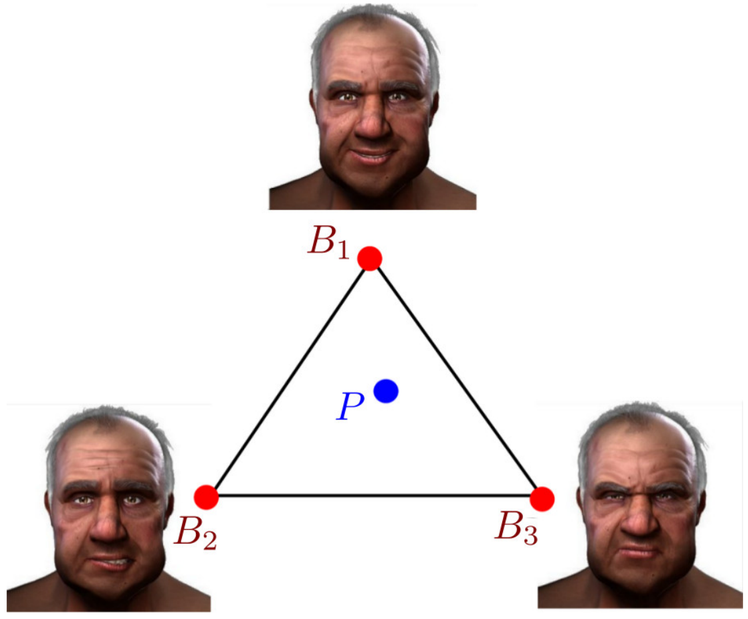
ex. 30% happy, 50% suprised, 20% tired

- Per-vertex formulation $p_i(t) = \sum_{k}^{N_{poses}} \omega_k(t)\, b_{ik}$

  - p_i: ith deformed vertex coordinates
  - b_{ik}: Initial ith vertex coordinates at pose k
  - w_k: Interpolation weight for pose k.

- Matrix formulation $\mathbf{p}(t) = \mathrm{B}\,\omega(t)$

$$\begin{pmatrix} p_1(t) \\ p_2(t) \\ \vdots \\ \vdots \\ p_N(t) \end{pmatrix} = \underbrace{\begin{pmatrix} b_{11} & \dots & b_{1N_{poses}} \\ b_{21} & \dots & b_{2N_{poses}} \\ & \vdots & \\ & \vdots & \\ b_{N1} & \dots & b_{NN_{poses}} \end{pmatrix}}_{all\ vertices\ from\ all\ poses} \underbrace{\begin{pmatrix} \omega_1(t) \\ \vdots \\ \omega_{N_{poses}}(t) \end{pmatrix}}_{weights\ per\ pose}$$



Coordinate differences

Often simpler to add/remove some expression w/r neutral pose

Add smile, open more the left eye, etc.

Idea:

- Set b^0 to be neutral pose
- Precompute *poses differences* $d_k = b_k - b^0$
- Compute $p_i(t) = b_i^0 + \sum_k^{N_{poses}} \omega_k(t)\, d_{ik}$

In matrix formulation $\mathbf{p}(t) = \mathbf{b^0} + \mathrm{D}\,\omega(t)$

D: matrix of vertex differences between poses.

Blend shapes - Summary

Standard for facial/complex shapes deformation

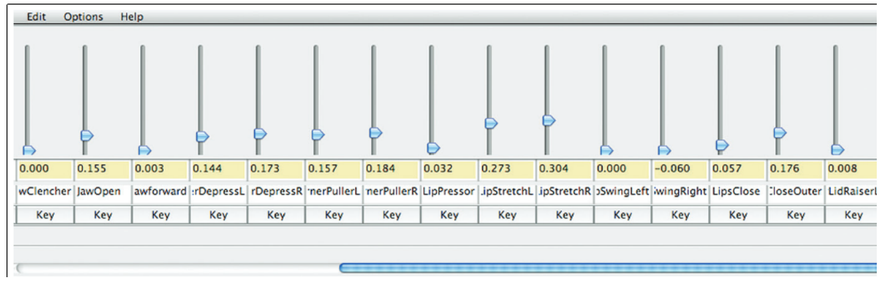
(+) Allow to add/substract local expressions from pre-set poses

even extrapolate

(+) Allow expression transfert

Keep same D for difference faces b^0

Requires same connectivity



Requires non redundant/interfering poses

D is not an othogonal matrix

Different weights can give the same result

PCA can orthogonalize the matrix

but weights are less intuitive (not positive)

To go beyond:

[J.P. Lewis et al. Practice and Theory of Blendshape Facial Models. EG STAR 2014]