Supplementary Material to SoftDECA

Nicolas Wagner
Ulrich Schwanecke
Mario Botsch

1 SIMULATION PARAMETERS

In the following, we describe all simulation parameters that haven been sampled during the creation of the SoftDECA training data. Moreover, we state the sampling range for each parameter. This list is not complete in the sense that SoftDECA is not committed to it. However, these parameters already provide a comprehensive test of SoftDECA's capabilities and allow for extensive individualization opportunities.

Dynamics We sample each of the parameters α, β, γ that steer the dynamic second order effects in a range from 0 to 2.

Constraint Weights All weights w_* associated with the constraints of $\phi^\dagger$ are sampled between 0.001 and 100.

Volume The target determinant in the volume energy E_{vol} is sampled from 0.5 to 1.5.

Maximum Strain We allow a varying amount of maximum soft tissue strain by adjusting the ϵ from 0.7 to 1.3.

Gravity An additional gravity force is applied in a range from standard earth's gravity up to two times the standard. Further, the gravity direction is sampled.

Skull We incorporate changes in the skull bones by sampling coordinate-wise scaling factors for both the cranium and jaw in the range from 0.5 to 1.5.

2 ENERGIES

In the following, we formally state all energies under optimization.

Volume & Strain

$$E_{\text{vol}}(t) = (\det(\mathrm{F}(t)) - 1)^2 \tag{1}$$

$$E_{\text{str}}(t) = \min_{R \in SO(3)} \|\mathrm{F}(t) - R\|_F^2 \tag{2}$$

$\mathrm{F}(t)$ denotes the deformation gradient of a tetrahedron t, $R \in SO(3)$ the optimal rotation, and $\|\cdot\|_F^2$ the Frobenius norm.

Bending

$$E_{\text{curv}}(x, B) = A_x \left\|\Delta x - R\Delta b_x\right\|^2 \tag{3}$$

The matrix $R \in SO(3)$ denotes the optimal rotation keeping the vertex Laplacian Δx as close as possible to its initial value Δb_x. The vertex Laplacian is discretized using the cotangent weights and the Voronoi areas A_x [Botsch et al. 2010].

Soft Dirichlet

$$E_{\text{tar}}\left(x, S_{\text{exp}}\right) = \left\|x - s_x\right\|^2, \tag{4}$$

attracts each vertex x of the skin surface S to the corresponding vertex s_x from the target expression S_{exp}.

Fitting Distances

$$E_{\text{dist}_2}\left(X, \hat{S}, D\left(\hat{S}\right)\right) = \sum_{x \in X} \left(\|x - s_x\| - d_x\right)^2 \tag{5}$$

ensures that for each vertex $x \in X$ the predicted distance $d_x \in D(\hat{S})$ is adhered to.

3 TEMPLATE LAYERED HEAD MODEL

Table 1 states the cardinality of each component of the layered head model template. By subdividing the wrap meshes or the triangle prisms between the wraps, the resolution of the template tetrahedron meshes can easily be adjusted. We will provide a mapping between the DECA and our topology.

Mesh	$S_{\mathcal{T}}$	$B_{\mathcal{T}}$	$M_{\mathcal{T}}$	$\hat{S}_{\mathcal{T}}$
#Vertices	35621	14572	16388	7826
#Faces / #Tetrahedrons	71358	28856	32370	15648

Mesh	$\hat{B}_{\mathcal{T}}$	$\hat{M}_{\mathcal{T}}$	$\mathbb{S}_{\mathcal{T}}$	$\mathbb{M}_{\mathcal{T}}$
#Vertices	7826	7826	49852	
#Faces / #Tetrahedrons	15648	15648	123429	73681

Table 1: Template sizes.

4 NETWORK DIMENSIONS

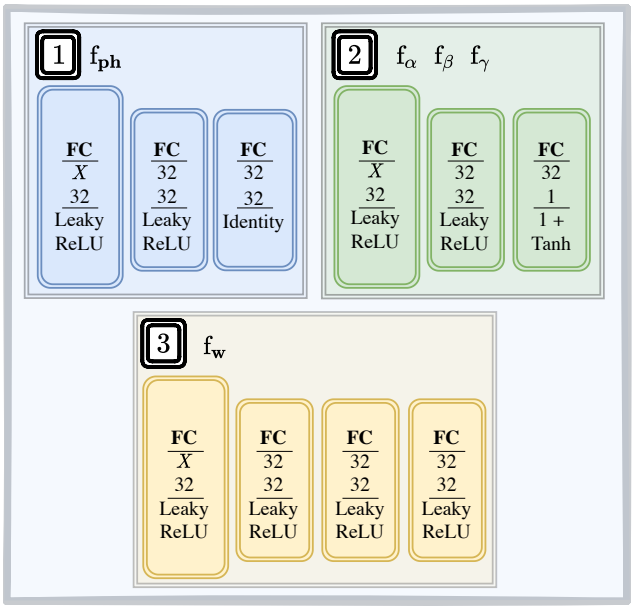

Figure 1: Network dimensions. Each fully connected layer (FC) is represented as a box. For each FC, the input and output dimensions are stated as well as the applied activation function.

REFERENCES

Mario Botsch, Leif Kobbelt, Mark Pauly, Pierre Alliez, and Bruno Lévy. 2010. *Polygon mesh processing*. CRC press.