Final Presentation

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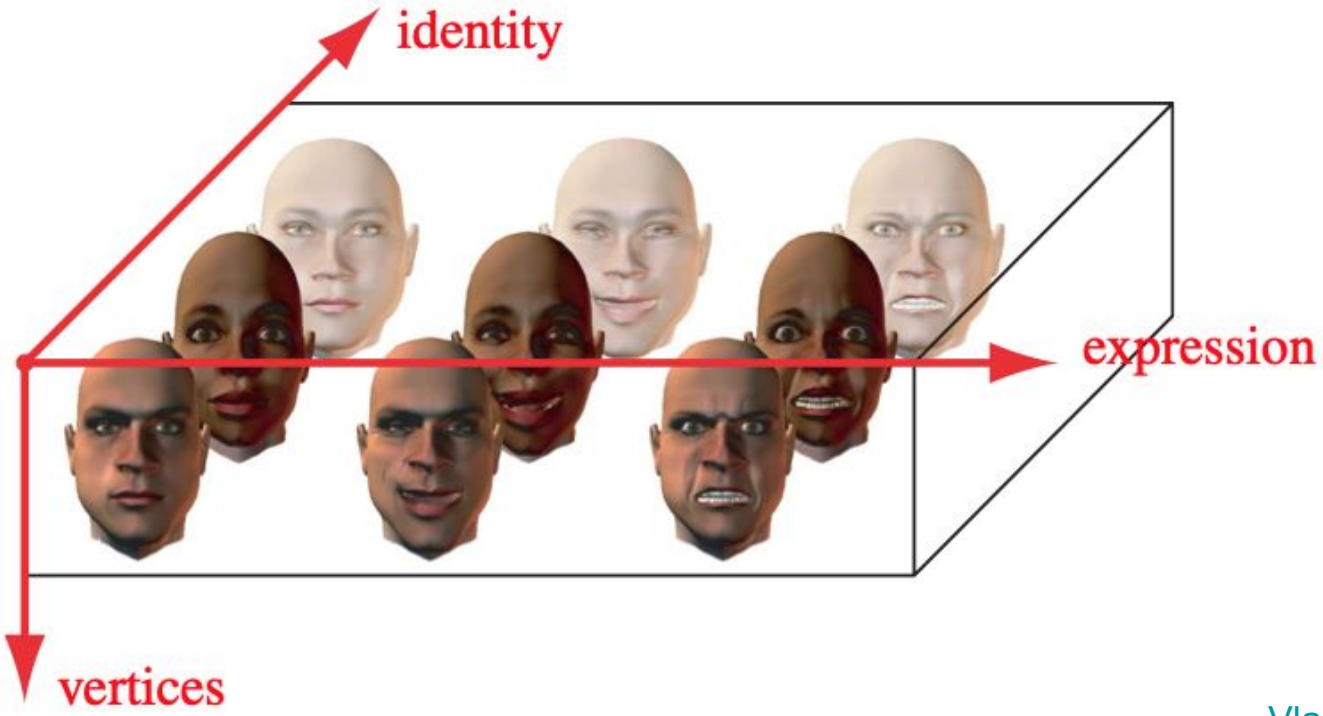
Bonus

Multi-Linear Face Model

DECA - Image to 3D Mesh

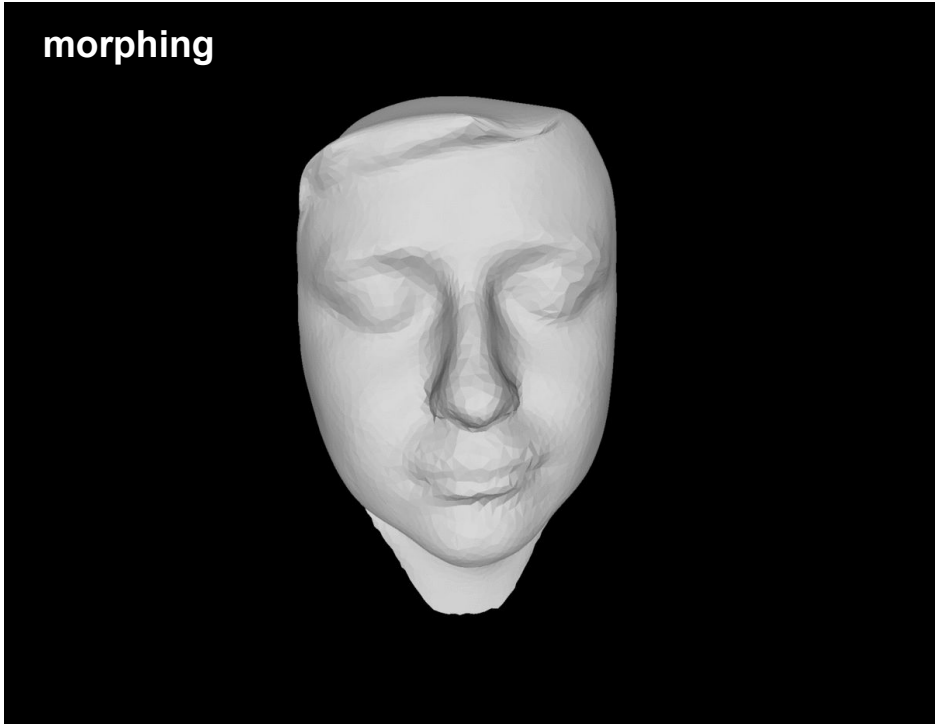
DL based landmark placement

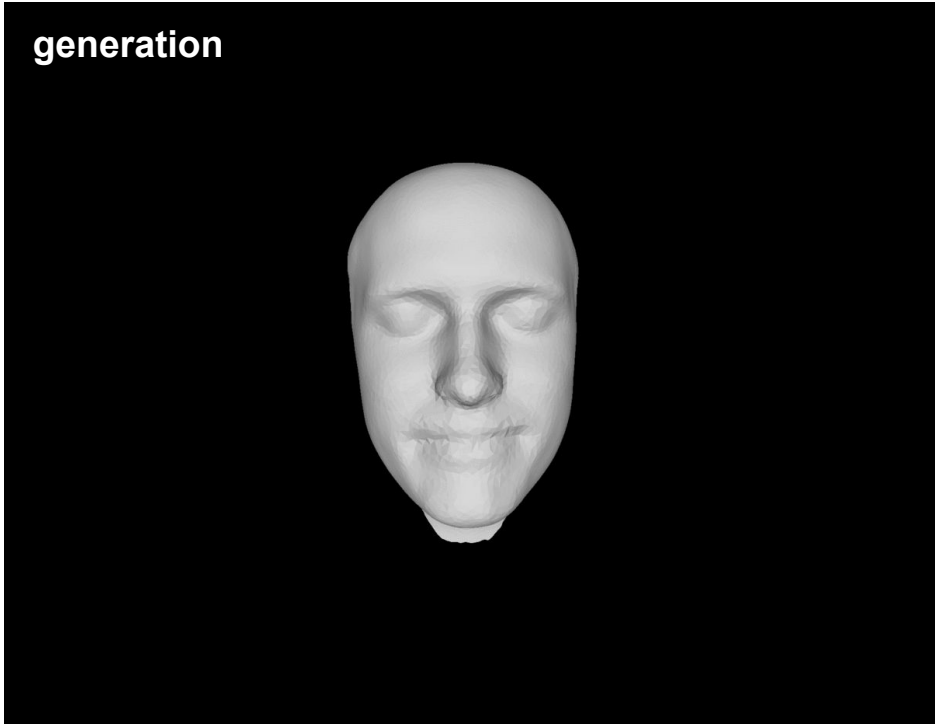
Multi-Linear Face Model (MLM)



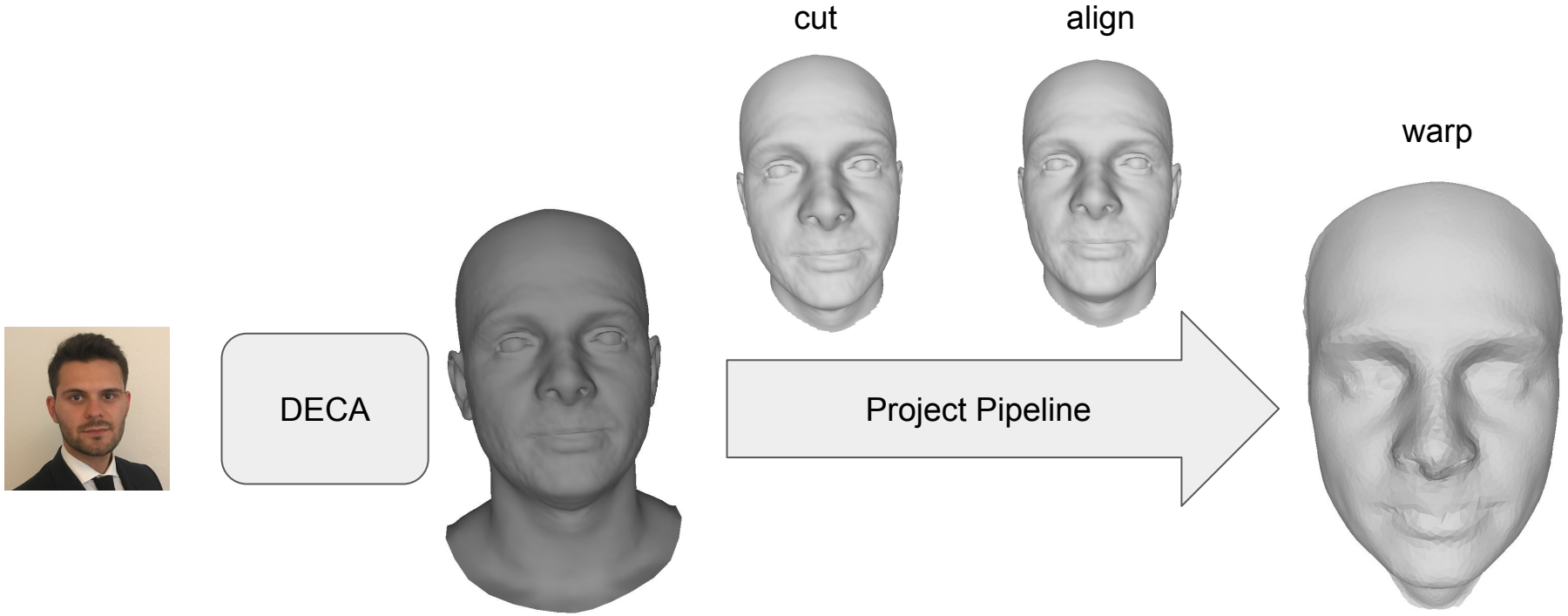
Vlasic et al.
SIGGRAPH '05

MLM space



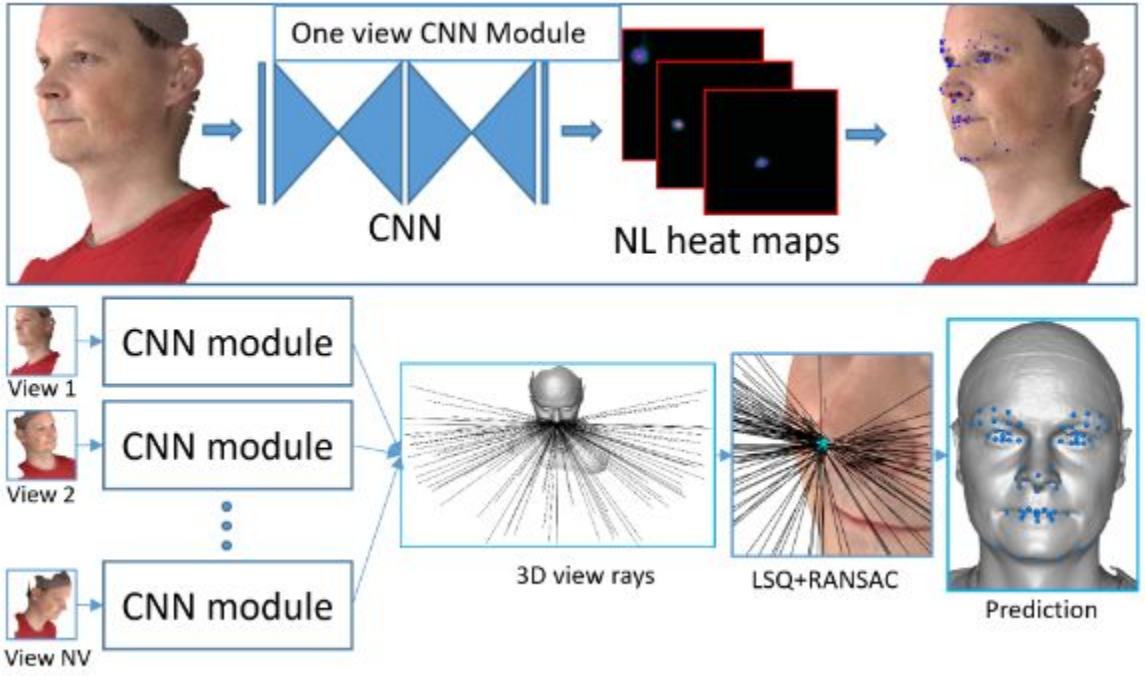


DECA - 3D Mesh Reconstruction from Single Image

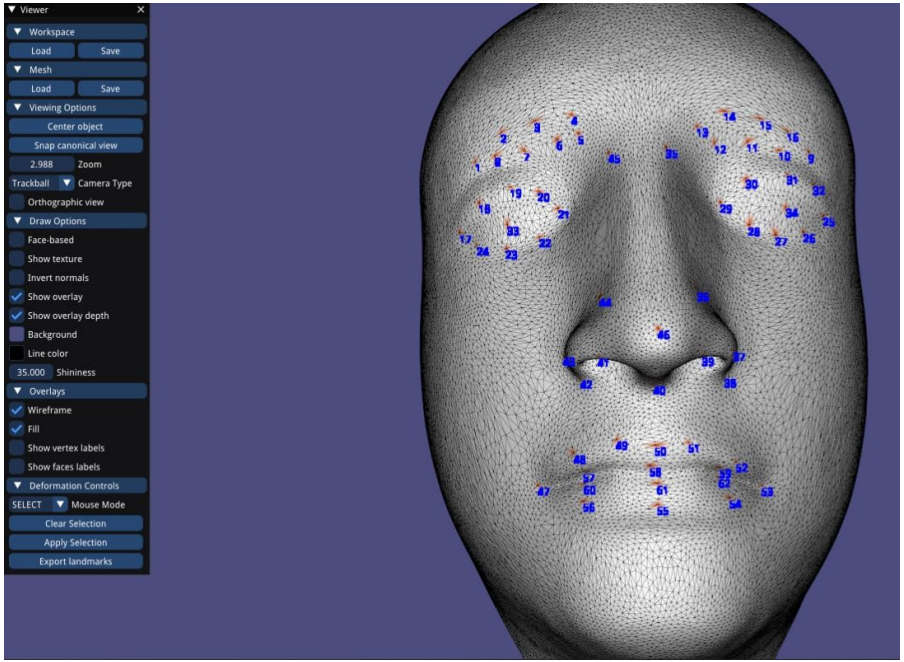


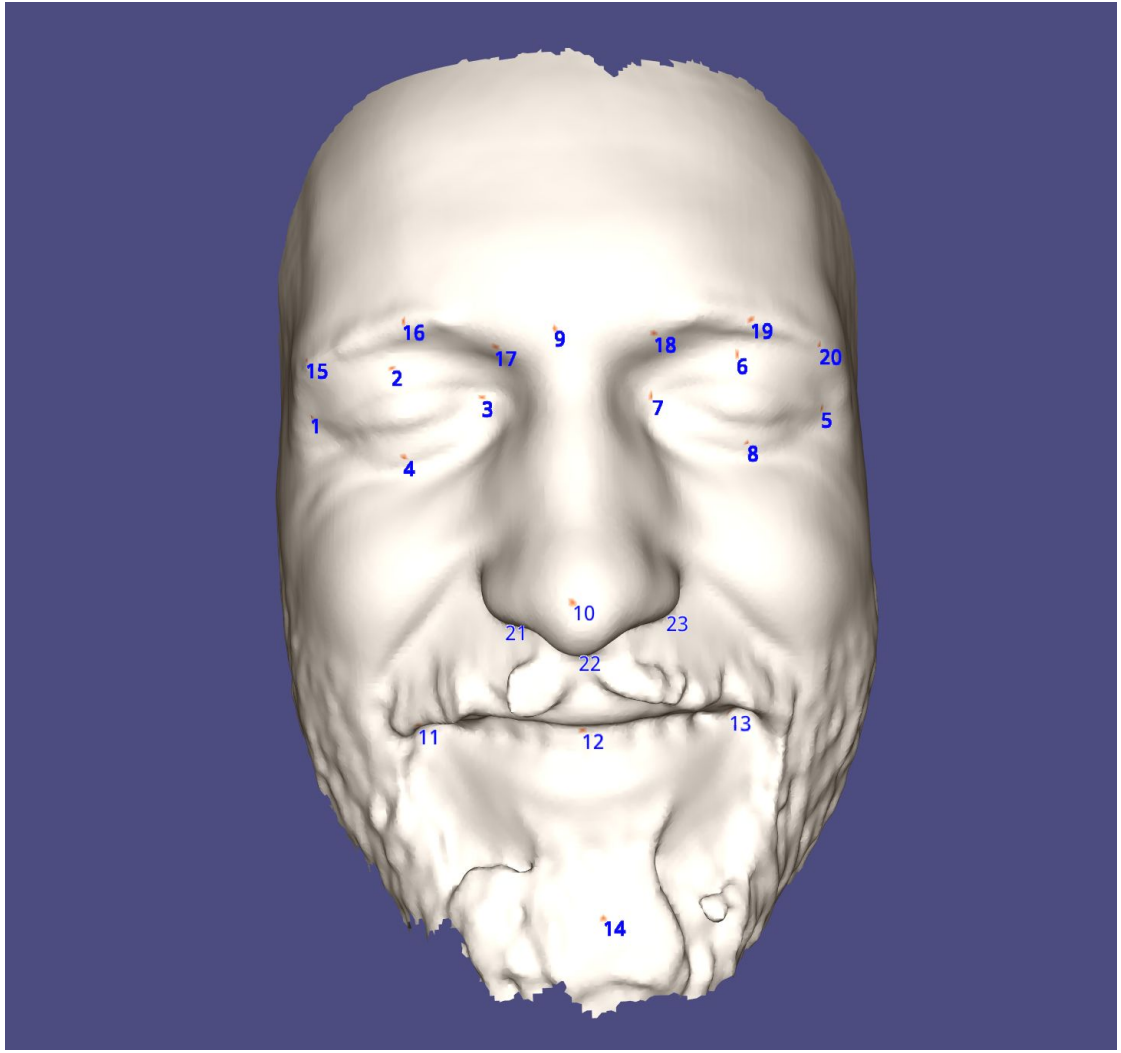
Feng et al.
SIGGRAPH '21

Deep learning based landmark placement



DL landmark placement - template obstacle




16
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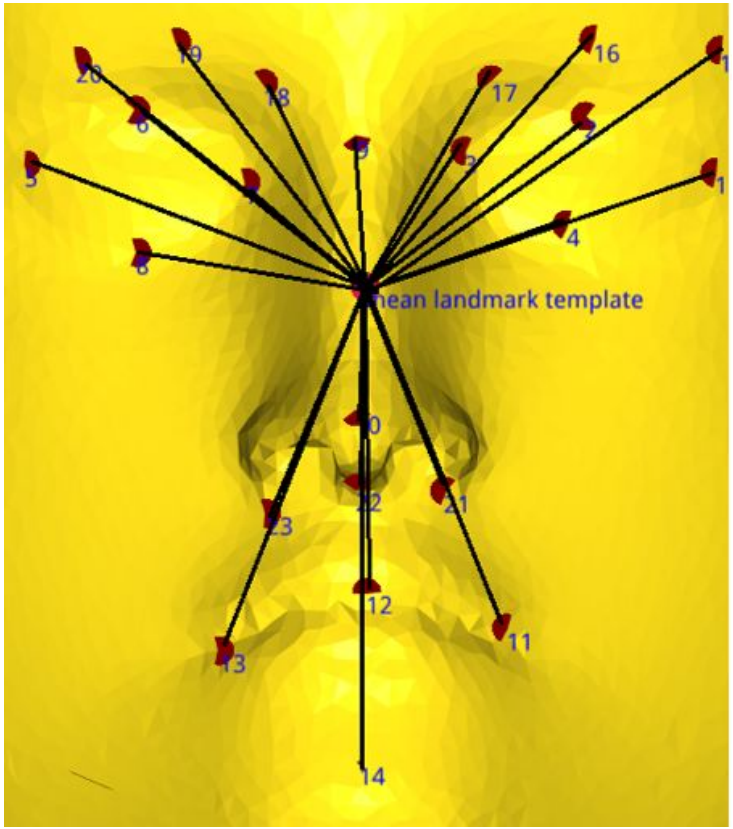
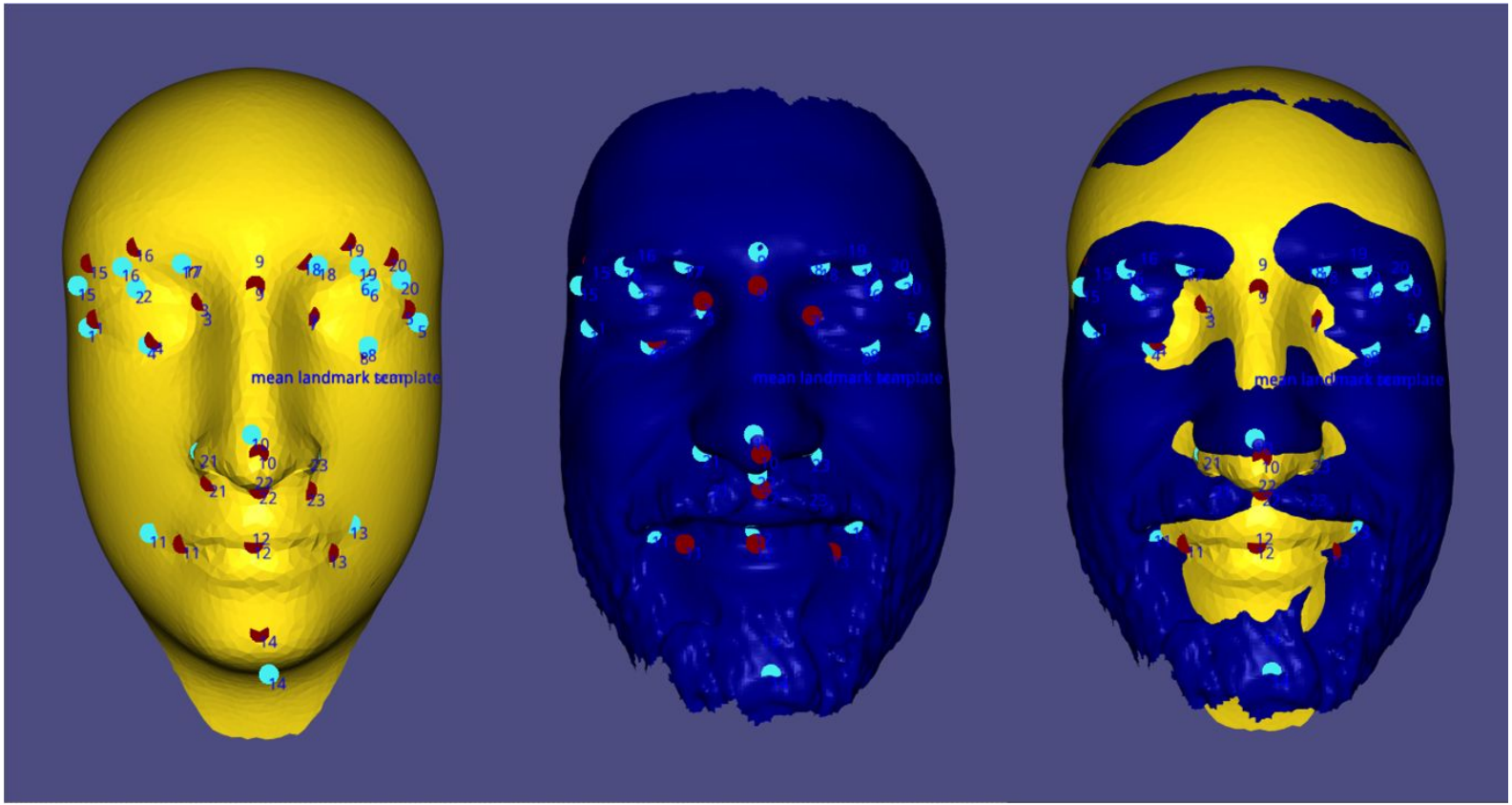
Optimal Scale Factor for Rigid Alignment



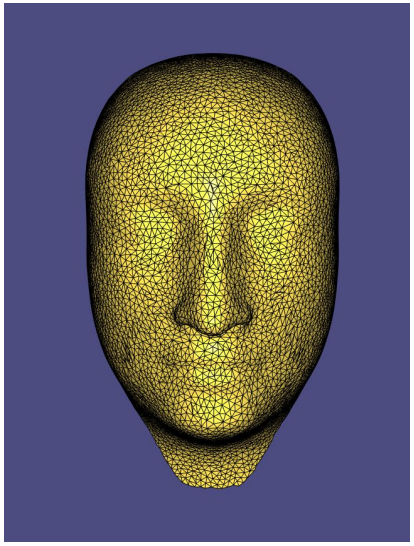
$$\frac{1}{N}\sum_{i=1}^{N}(lm_i^{template} - mean\_lm^{template}) = S * \frac{1}{N}\sum_{i=1}^{N}(lm_i^{scan} - mean\_lm^{scan}) \Rightarrow$$

$$S = \frac{\frac{1}{N}\sum_{i=1}^{N}(lm_i^{template} - mean\_lm^{template})}{\frac{1}{N}\sum_{i=1}^{N}(lm_i^{scan} - mean\_lm^{scan})}$$

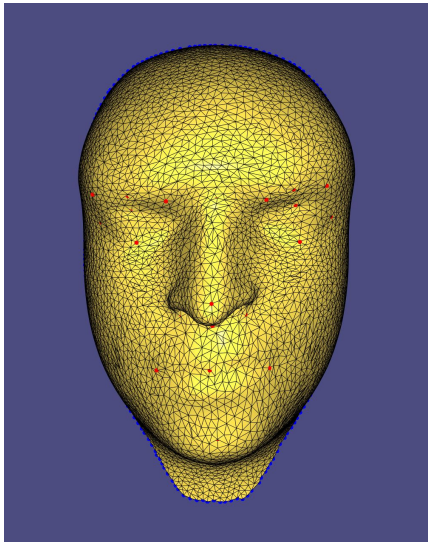
Rigid Alignment



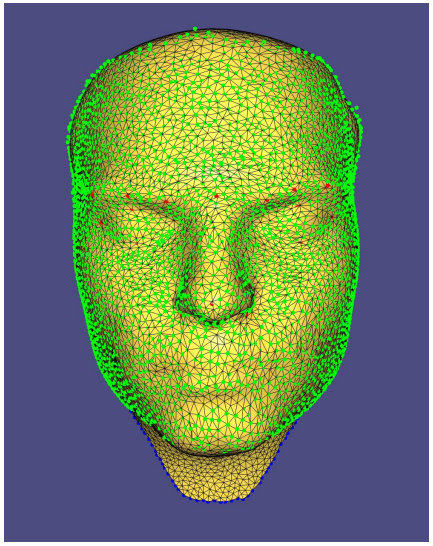
Non-rigid alignment for lower resolution template



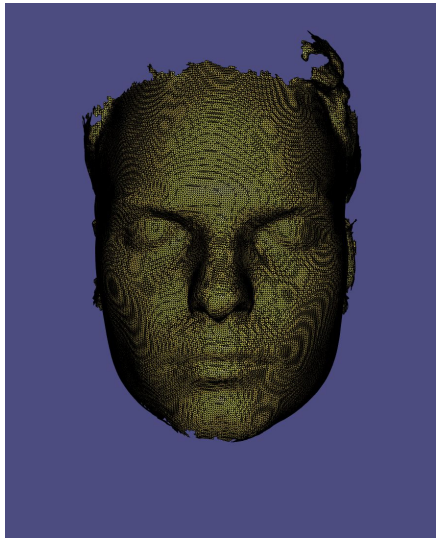
template



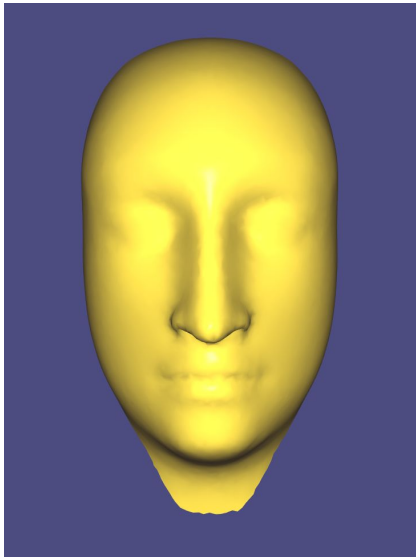
after 5 iterations with only landmark constraints + boundary constraints



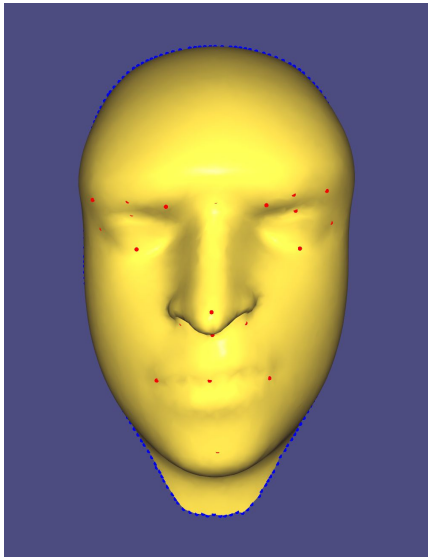
after 5 iterations with close point constraints + landmark constraints + boundary constraints



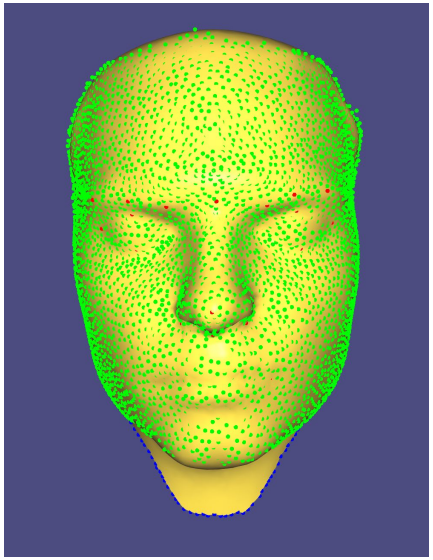
Scan



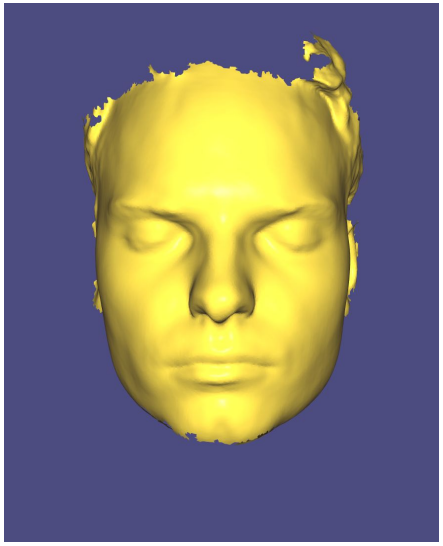
template



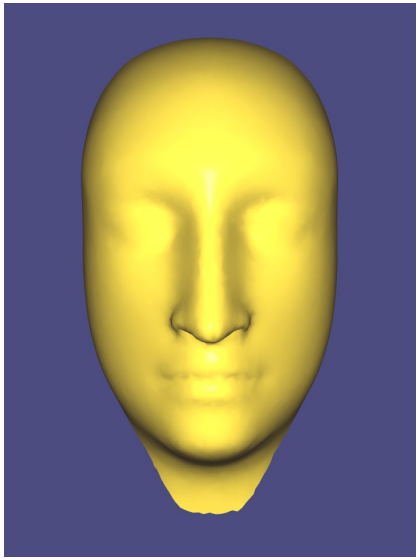
after 5 iterations with only landmark constraints + boundary constraints



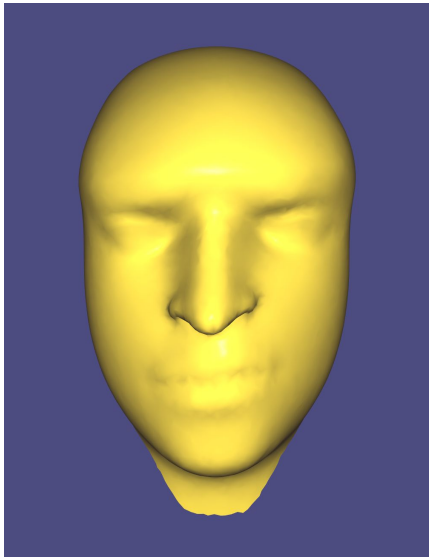
after 5 iterations with close point constraints + landmark constraints + boundary constraints



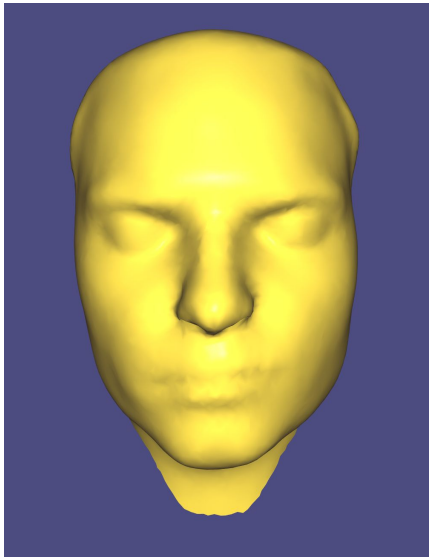
Scan



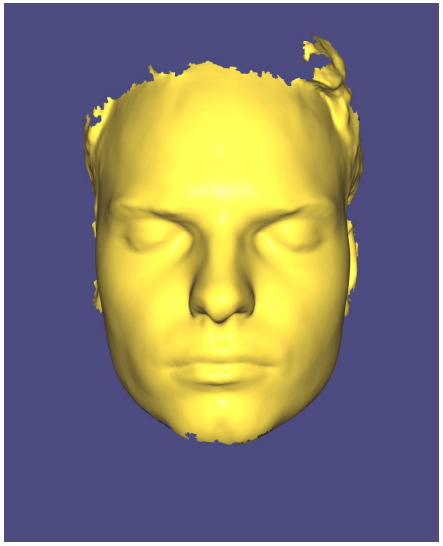
template



after 5 iterations with only landmark constraints + boundary constraints

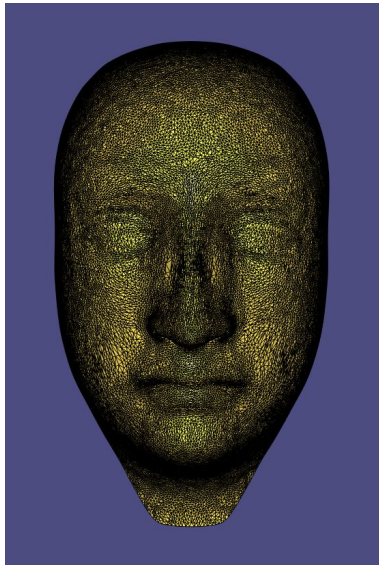


after 5 iterations with close point constraints + landmark constraints + boundary constraints

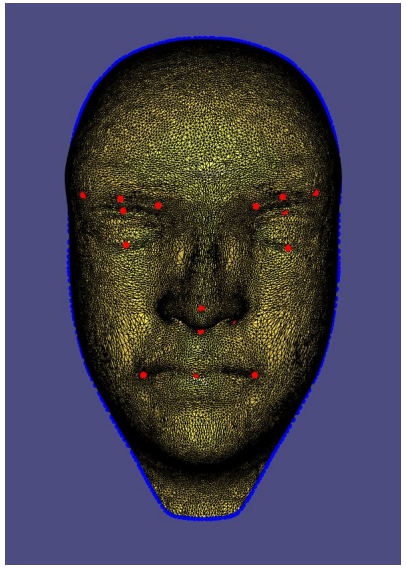


Scan

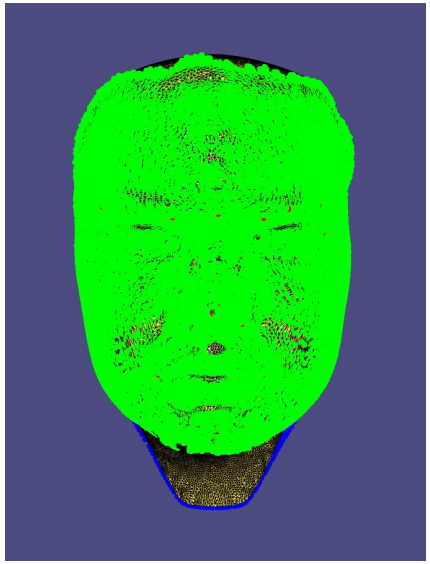
Non-rigid alignment for high resolution template



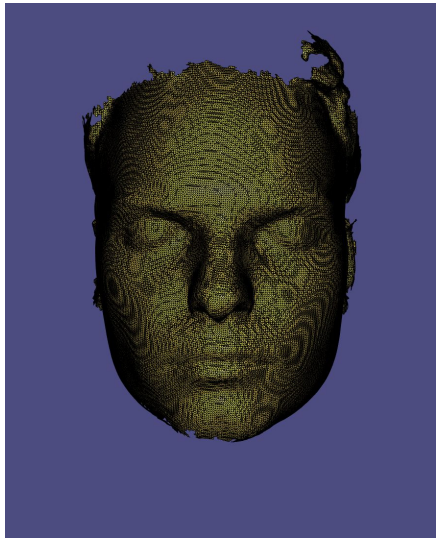
template



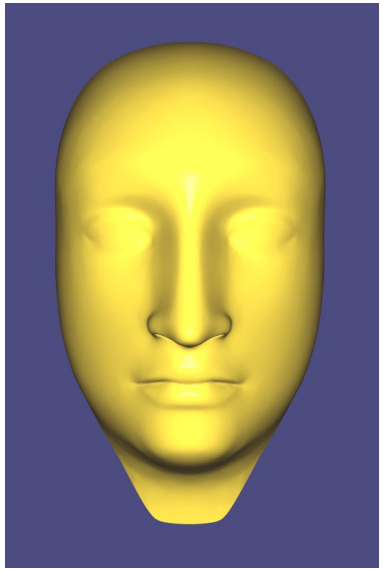
after 5 iterations with only landmark constraints + boundary constraints



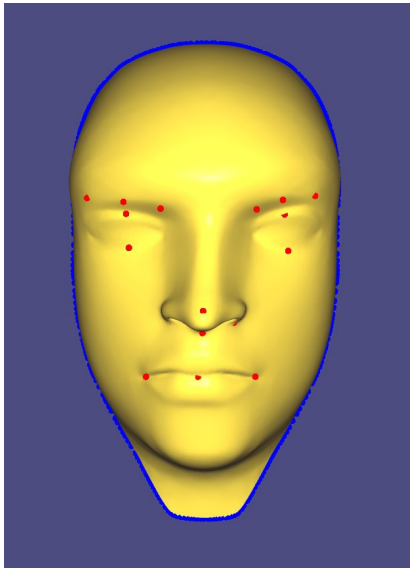
after 5 iterations with close point constraints + landmark constraints + boundary constraints



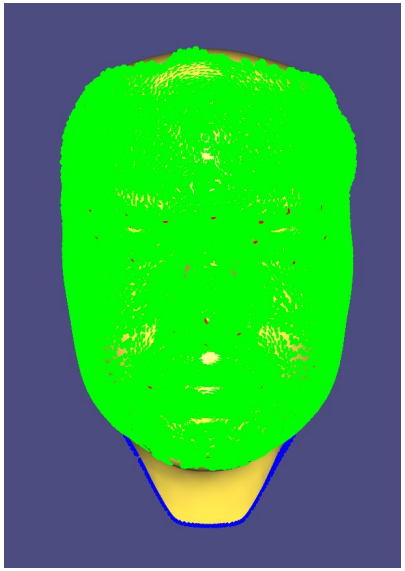
Scan



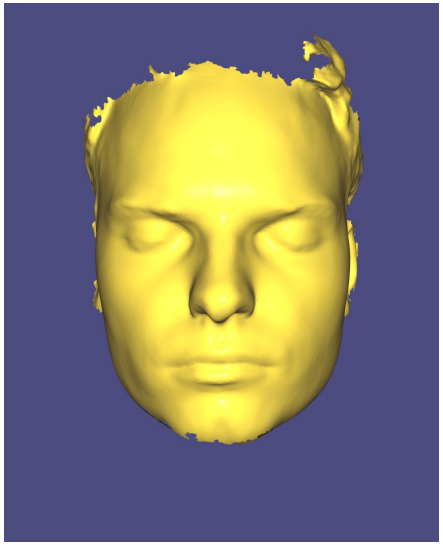
template



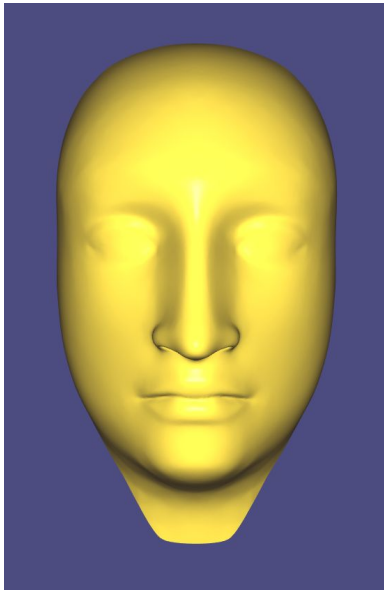
after 5 iterations with only landmark constraints + boundary constraints



after 5 iterations with close point constraints + landmark constraints + boundary constraints



Scan



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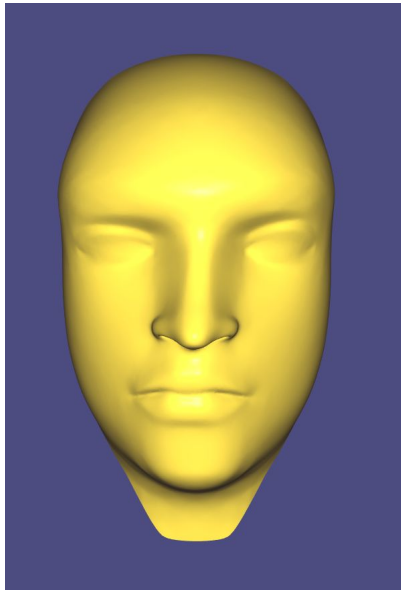
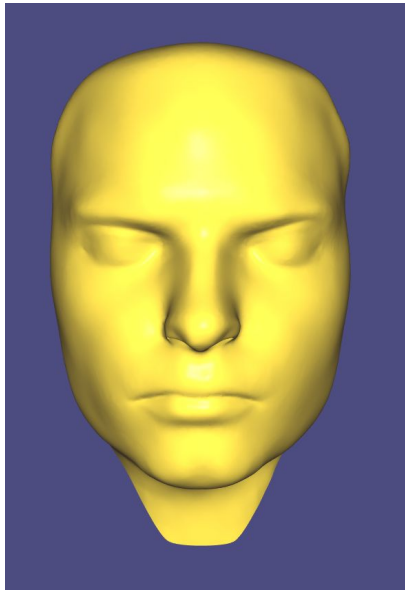
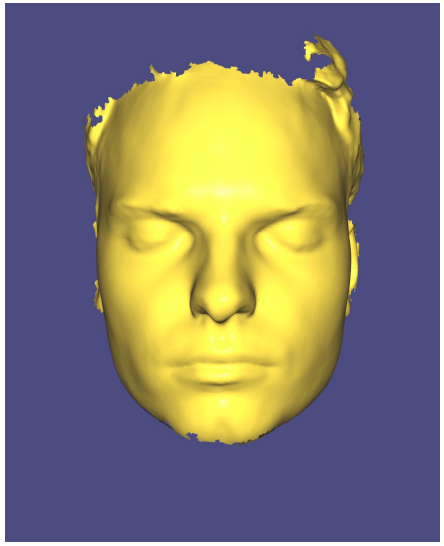


after 5 iterations with only landmark constraints + boundary constraints



after 5 iterations with close point constraints + landmark constraints + boundary constraints



Scan

Equations for non-rigid-alignment

- lagrange equation:
  - a lot of spikes and discontinuities despite minimizing the laplace energy
- assignment 5 method:
  - worked well for only landmark constraints
  - lots of discontinuities for closepoints
- winner:

$$\begin{bmatrix} L_{cot} \\ \lambda C_s \\ \lambda C_d \end{bmatrix} \mathbf{x}' = \begin{bmatrix} L_{cot}\mathbf{x} \\ \lambda C_{ws} \\ \lambda C_{wd} \end{bmatrix}$$

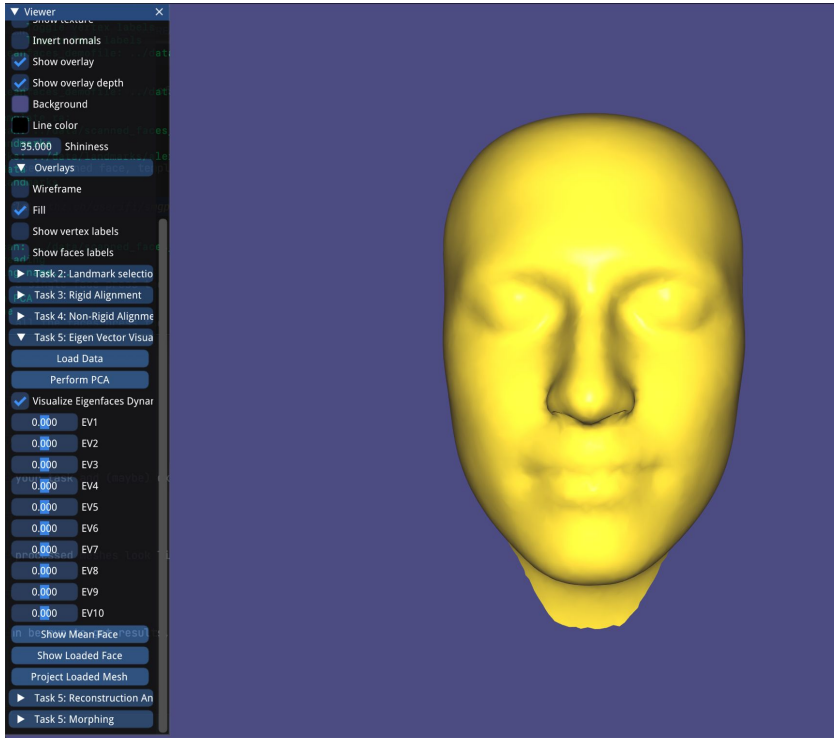
- Lcot: unweighted cotangent Laplacian
- Cs: weights for static constraints (boundary, landmarks)
- Cws: weighted coordinates for static constraints (original boundary, target landmarks)
- Cd: weights for dynamic constraints (vertices close enough to target face)
- Cwd: weighted coordinates for dynamic constraints (points on target)

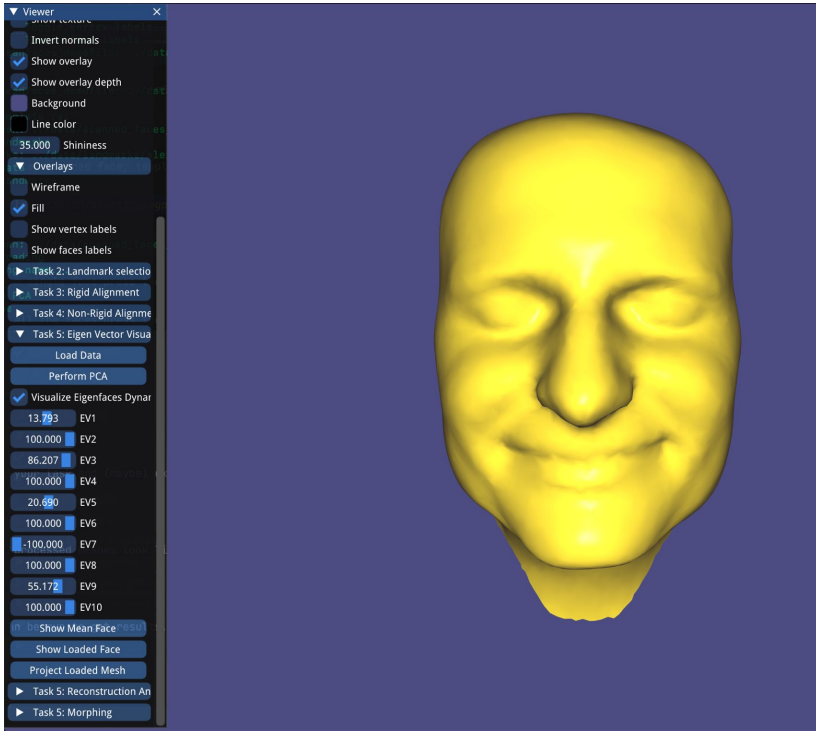
PCA

Theory - PCA and SVD

$$\frac{1}{n-1}XX^T = \frac{1}{n-1}(U\Sigma V^T)(U\Sigma V^T)^T = \frac{1}{n-1}U\Sigma^2 U^T$$

PCA - Eigenvectors





PCA - morphing