

Using Line Features for 3D Face Registration

BACHELOR THESIS PRESENTATION

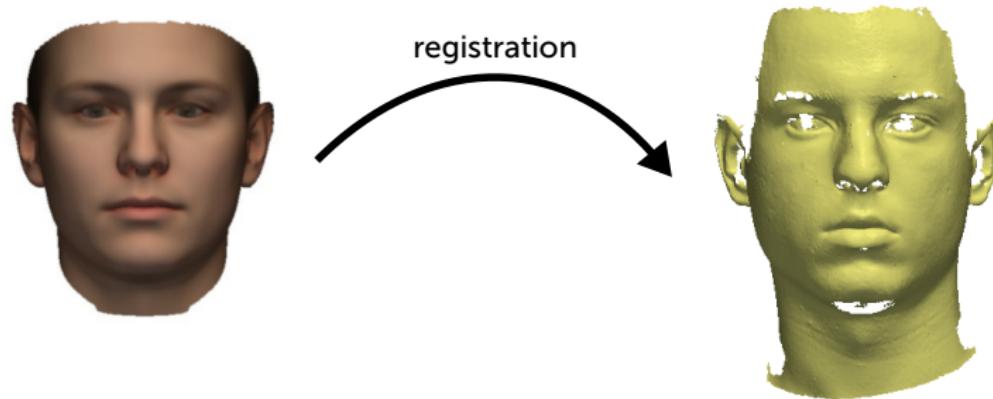
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July 30, 2013



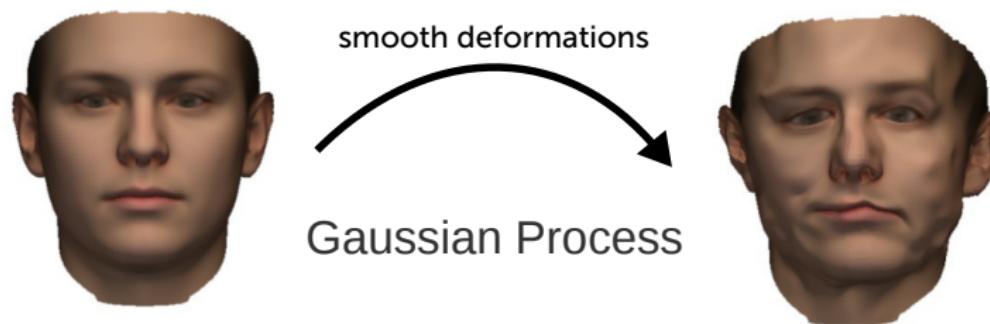
REGISTRATION OVERVIEW



REGISTRATION OVERVIEW



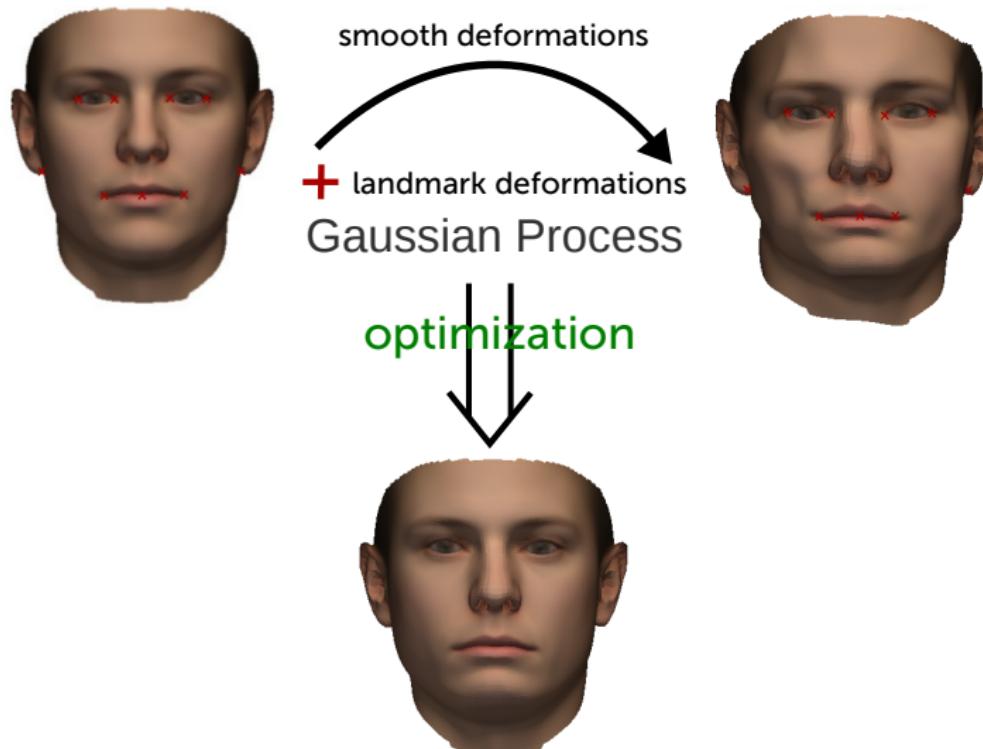
REGISTRATION OVERVIEW



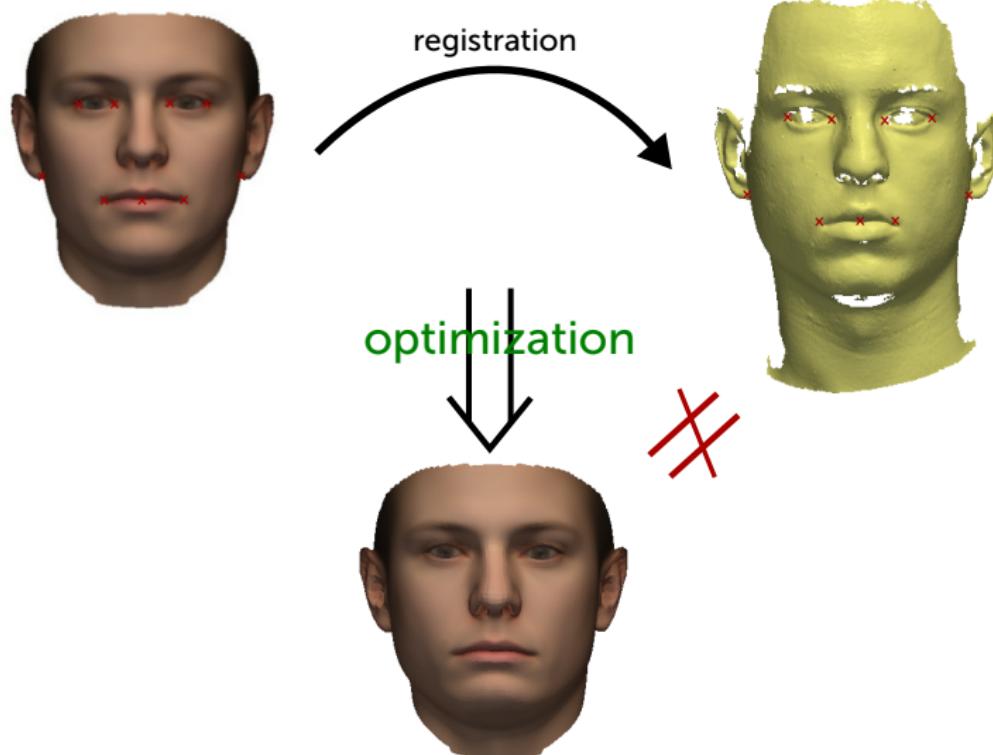
REGISTRATION OVERVIEW



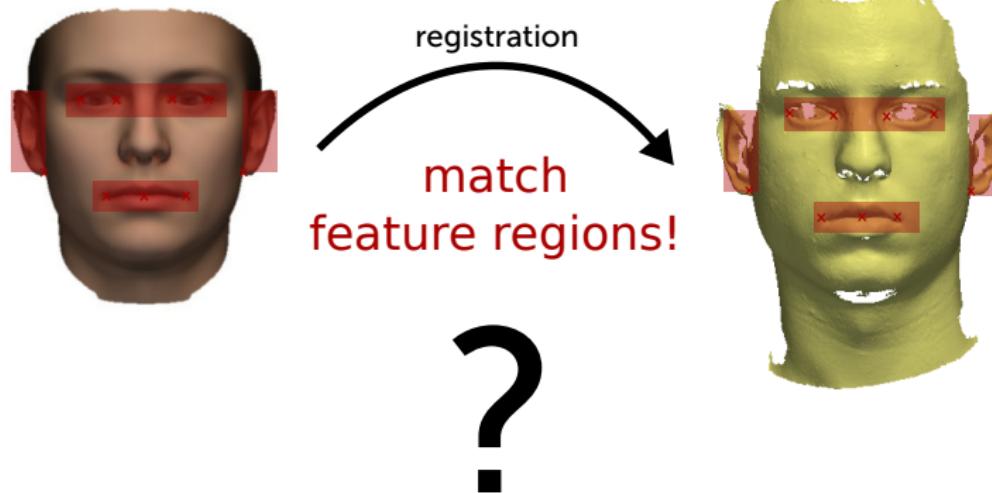
REGISTRATION OVERVIEW



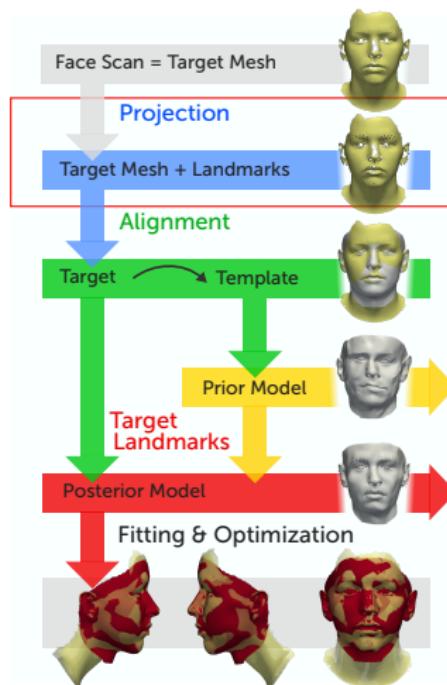
REGISTRATION OVERVIEW



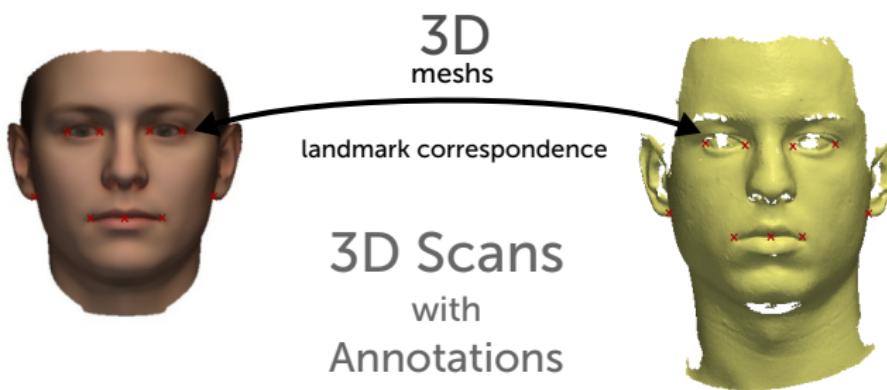
REGISTRATION OVERVIEW



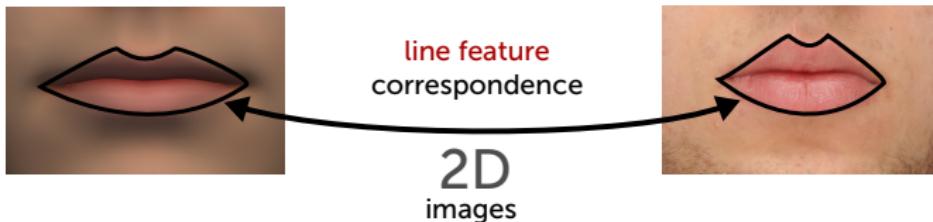
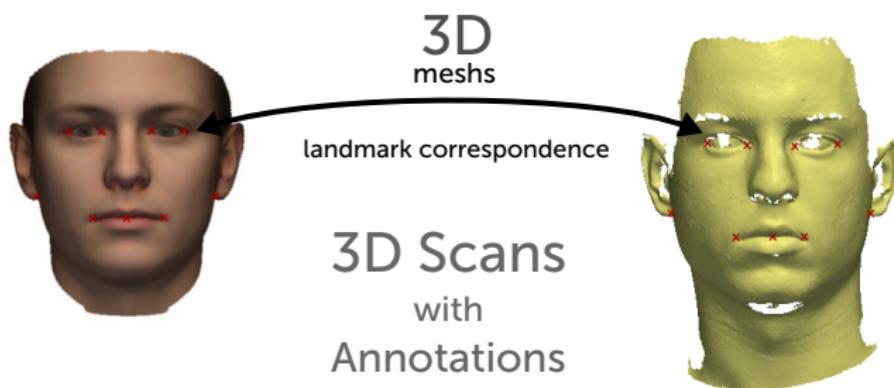
PIPELINE



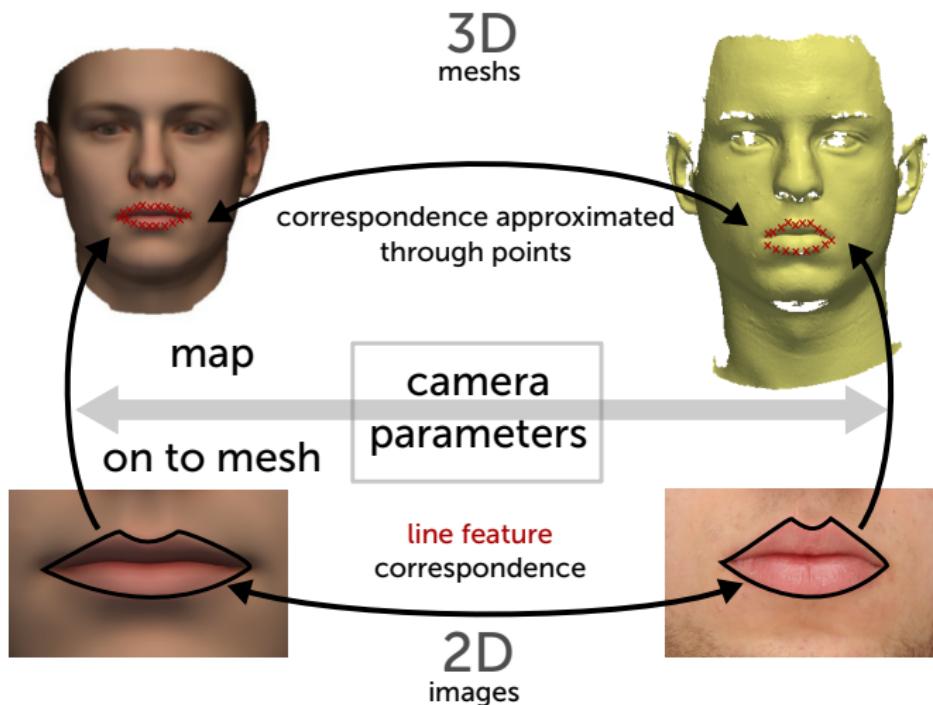
DATA AND CORRESPONDENCE



DATA AND CORRESPONDENCE

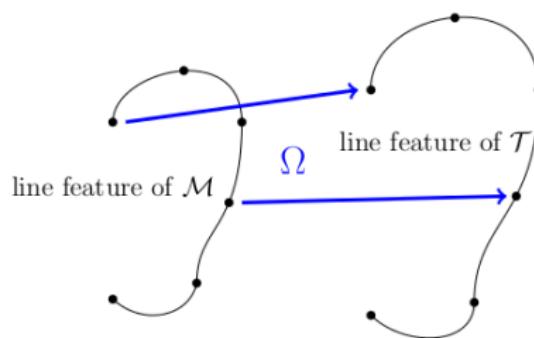


DATA AND CORRESPONDENCE



MAPPING LINE FEATURES

Idea: Sample points from the line features and use them as additional landmarks

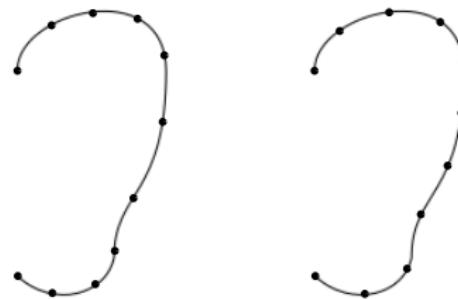


What about correspondence?



EQUIDISTANT SAMPLING

Approximate correspondance by sampling line features in equidistant intervals

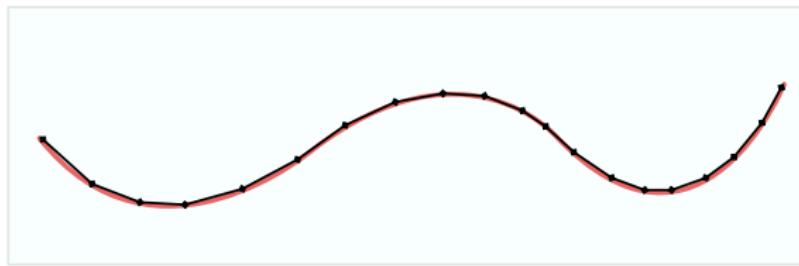




BÉZIER CURVES

Line features consist of Bézier curve segments
→ underlying parameter is not linear

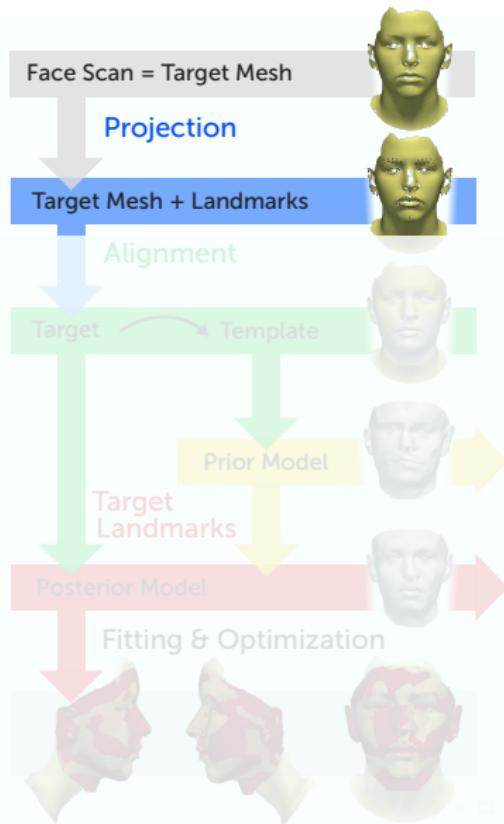
Approximate arc-length of curve through euclidean distance of sampled points



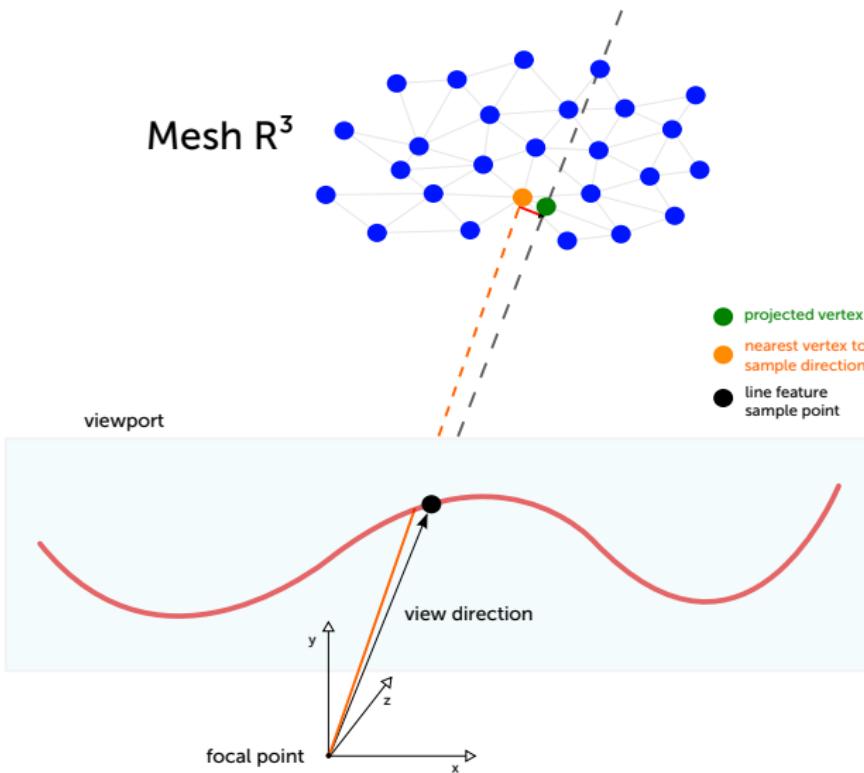
⇒ map point coordinates to approximated fractional length of curve



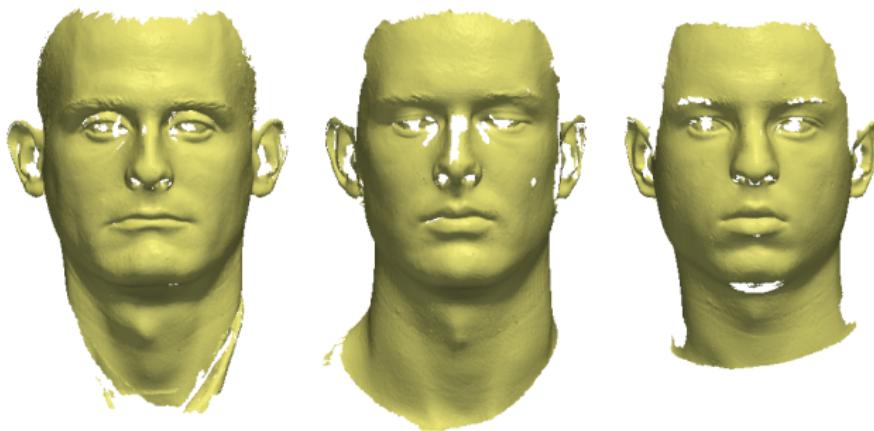
PIPELINE: PROJECTION



PROJECTION: 2D TO 3D

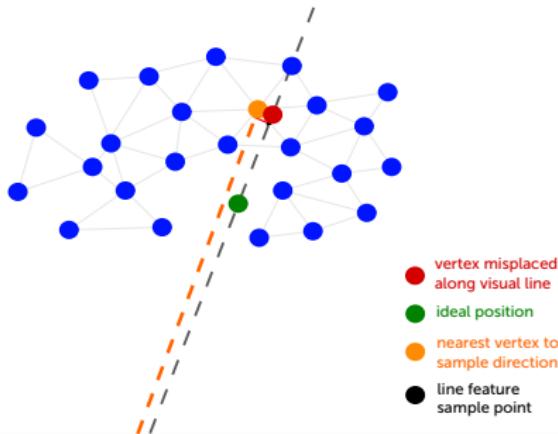


TARGET MESH HOLES

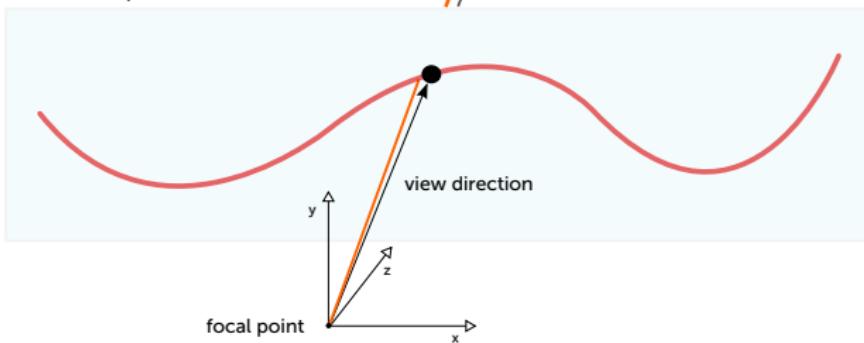


PROJECTION: HOLES

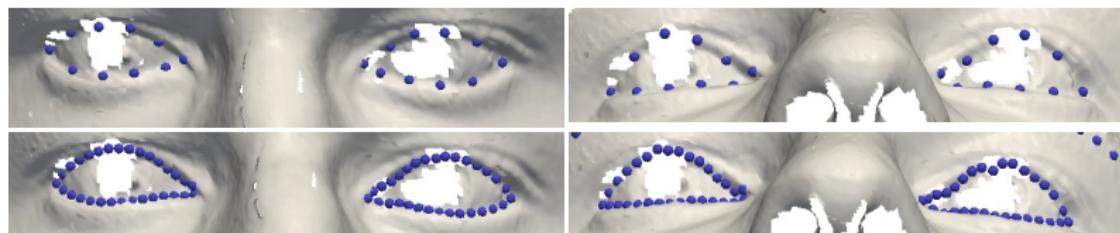
Mesh R³



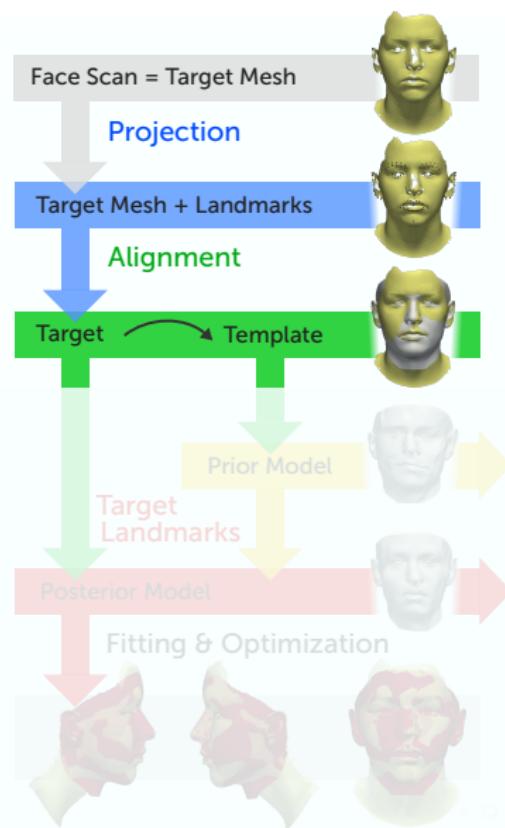
viewport



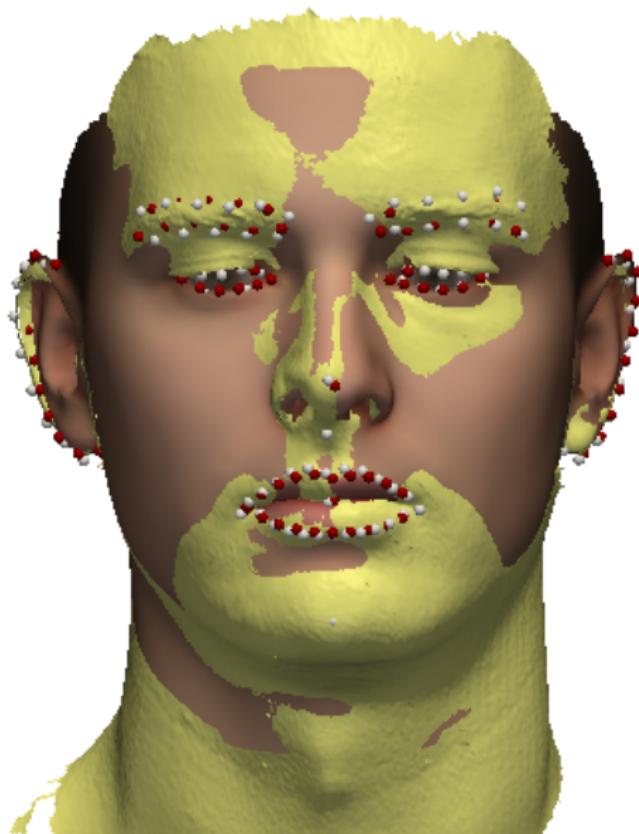
3D REPRESENTATION



TEMPLATE/TARGET ALIGNMENT



TEMPLATE/TARGET ALIGNMENT



GAUSSIAN PROCESS

intuitive: a generalization of the normal distribution to functions

a stochastic process where each random variable represents possible function values at a specific input point

GP PRIOR

sample functions from the space of possible inputs
these functions are defined by the covariance of the input points

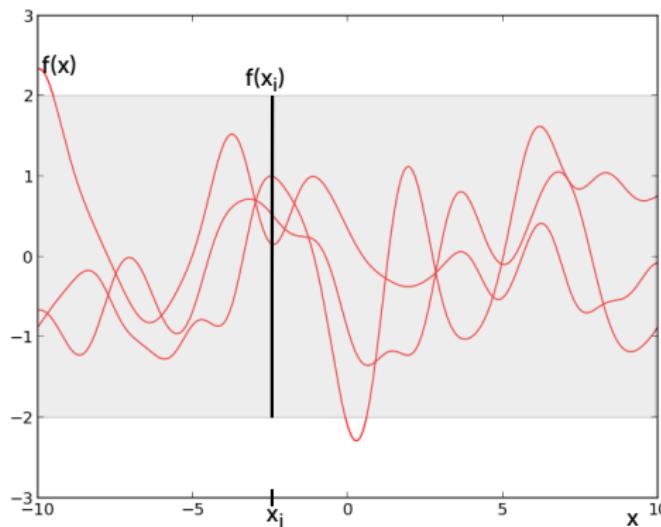


Figure: normal distribution over 1000 input points

GP POSTERIOR DISTRIBUTION

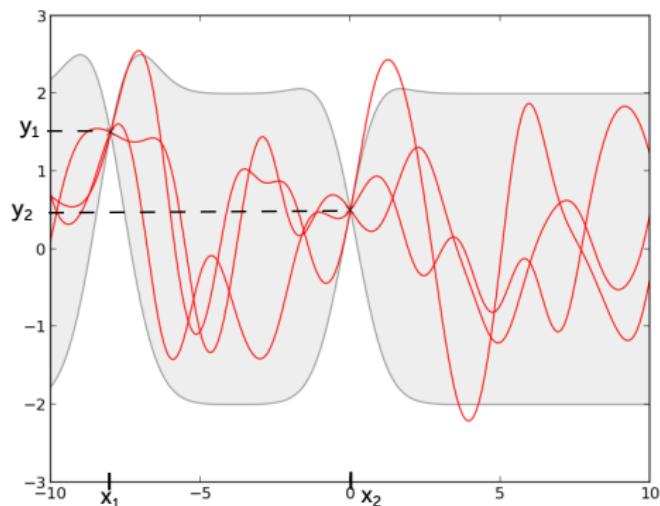


Figure: posterior distribution fixed at 2 input points



GP POSTERIOR DISTRIBUTION

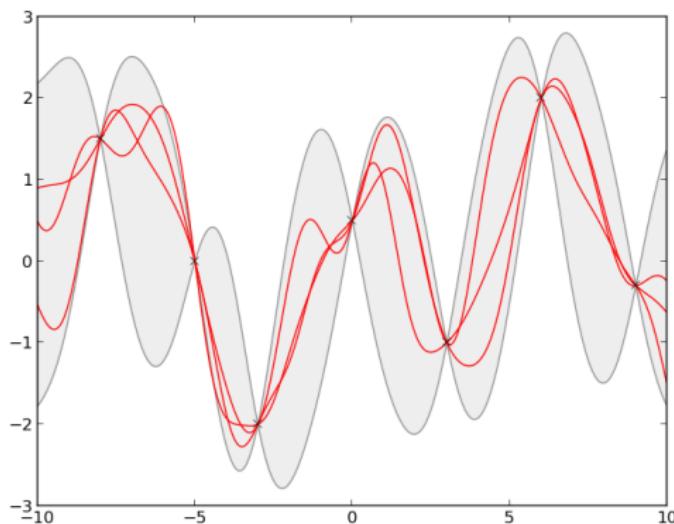


Figure: posterior distribution fixed at 7 input points

GPR IN 3D FACE REGISTRATION

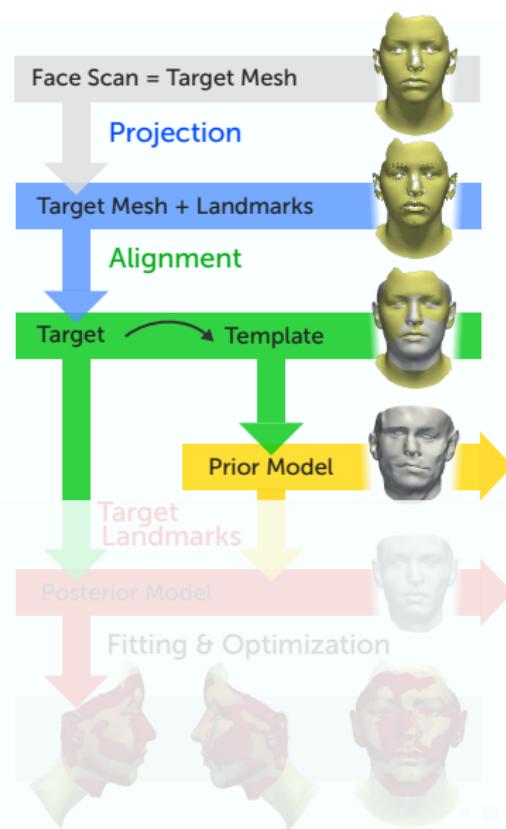
definition of Vector-valued GP

$$\mu : \mathcal{M} \rightarrow \mathbb{R}$$

$$k : \mathcal{M} \times \mathcal{M} \rightarrow \mathbb{R}^3 \times \mathbb{R}^3$$



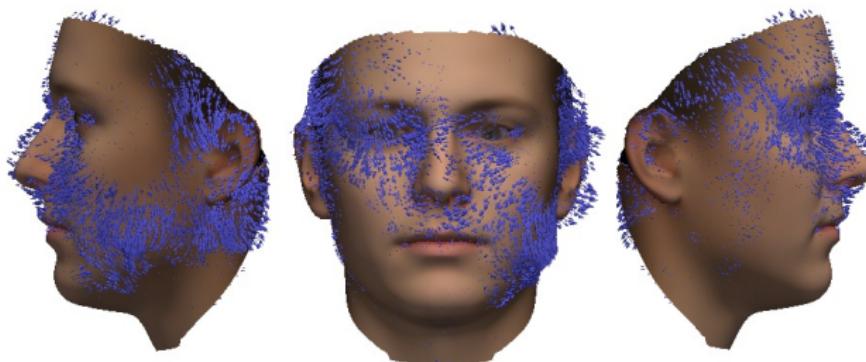
PIPELINE: DEFORMATION PRIOR



DEFORMATION PRIOR

build GP Prior from template mesh vertices

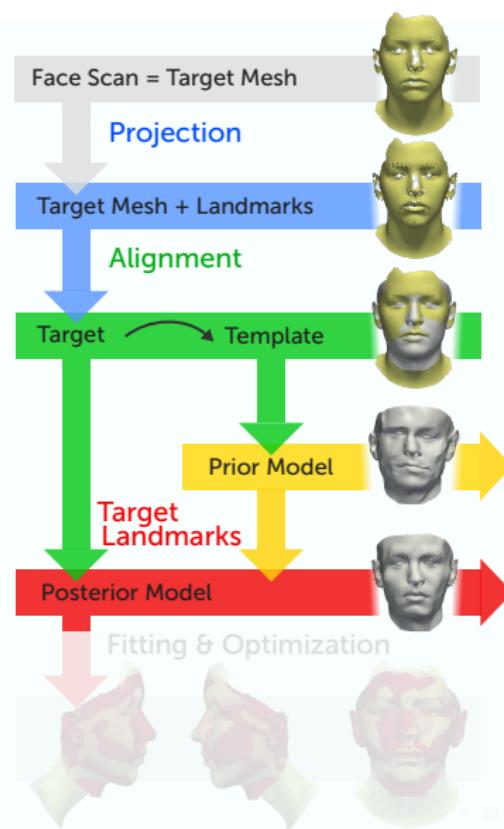
⇒ GP defines a distribution of possible deformations of the template mesh



PRIOR FACES



PIPELINE: DEFORMATION POSTERIOR

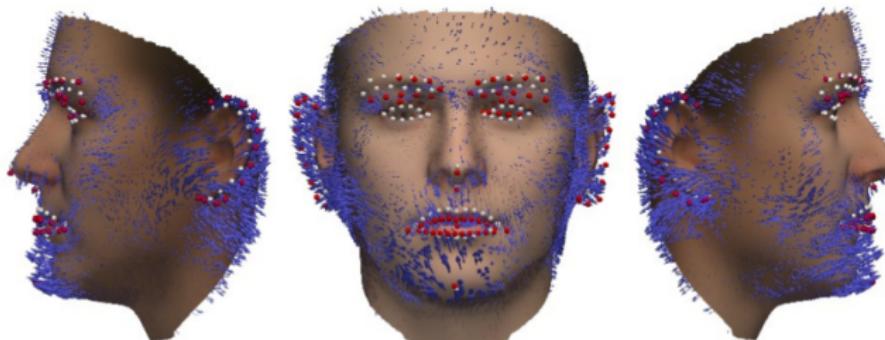


3D GP POSTERIOR

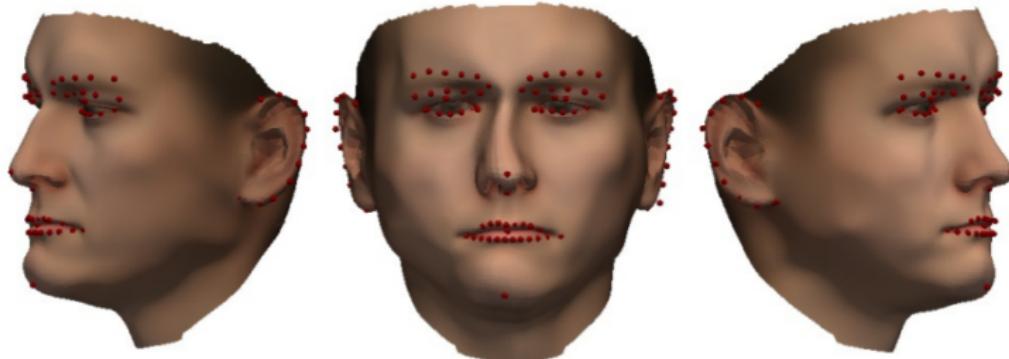
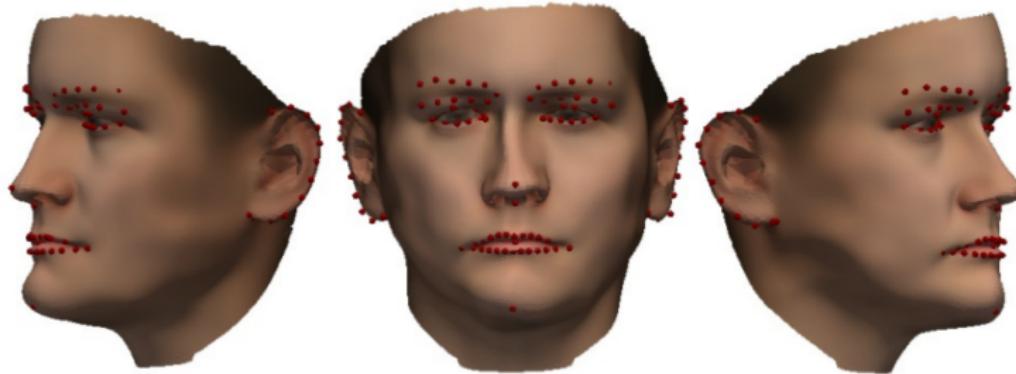
inference in the space of possible template surface deformations

training data: residuals of the line feature sample coordinates:

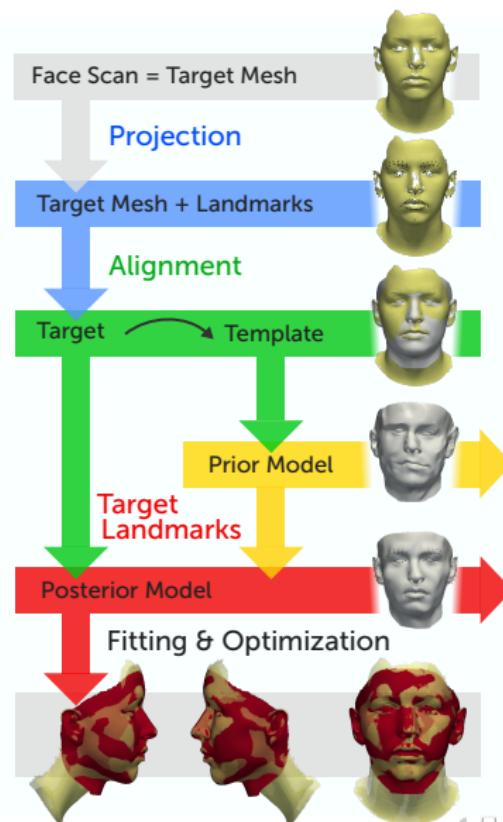
$$R = \{t - m | t \in L_T, m \in L_M\}$$



POSTERIOR FACES



FITTING & OPTIMIZATION



PARAMETRIC MODEL

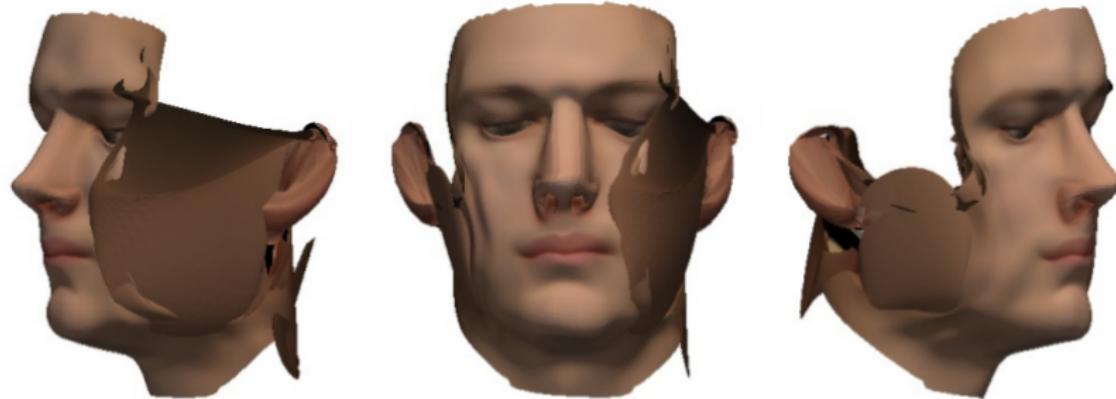
GP Posterior distribution of admissible deformations

How to optimize deformation samples?

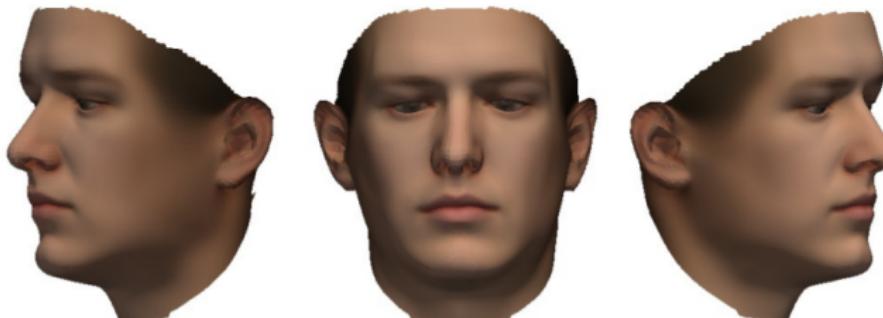
Mercer's theorem: distribution → parametric model

⇒ optimize model parameters
verify with loss function

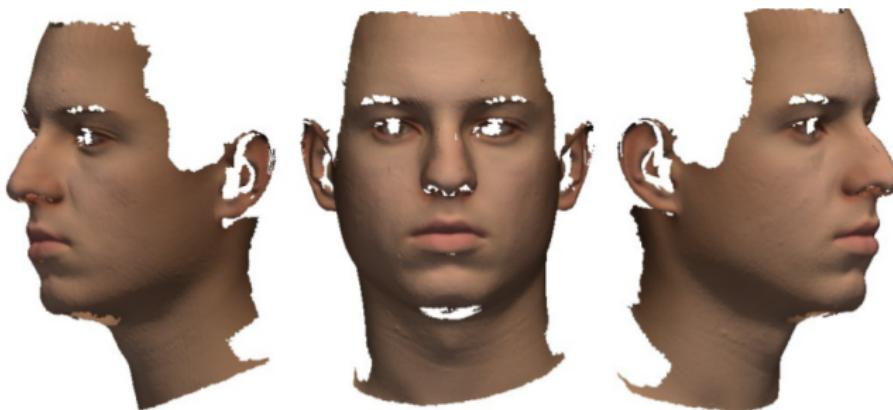
MEAN SQUARED ERROR



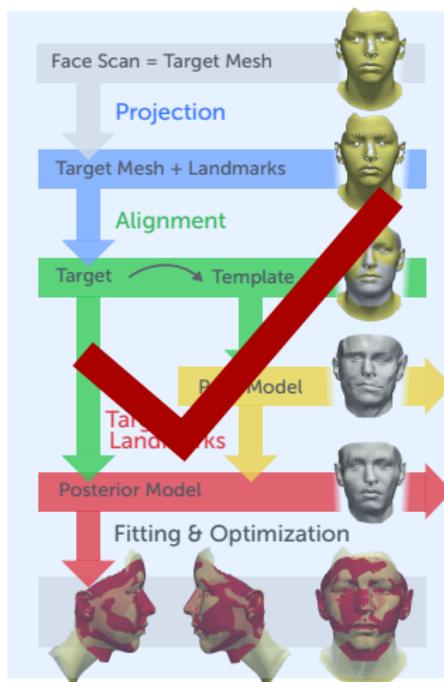
ROBUST ESTIMATOR



ROBUST ESTIMATOR



PIPELINE: CHECK

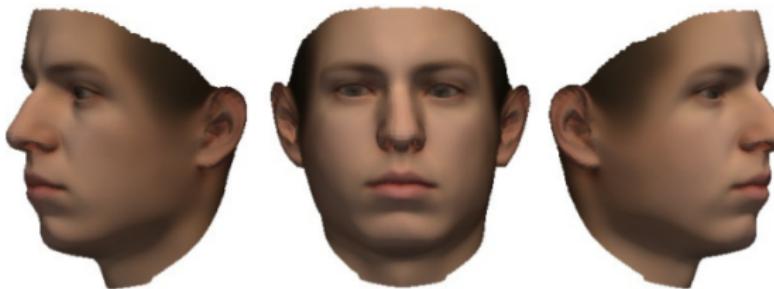
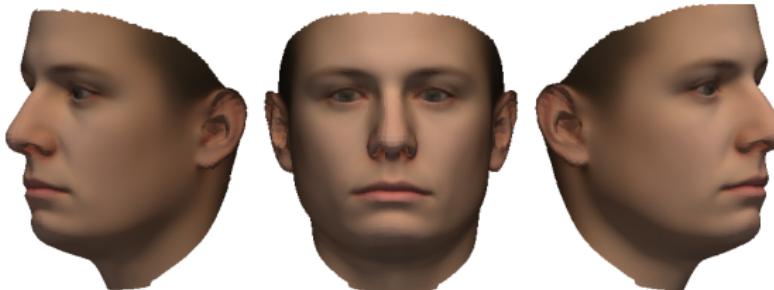


RESULTS

- ▶ COMPARISON: WITH \Leftrightarrow WITHOUT LINE FEATURES

- ▶ CARICATURES

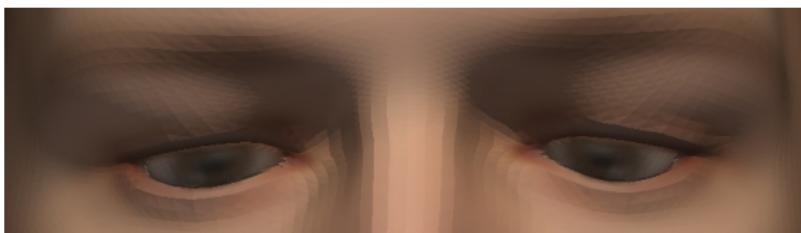
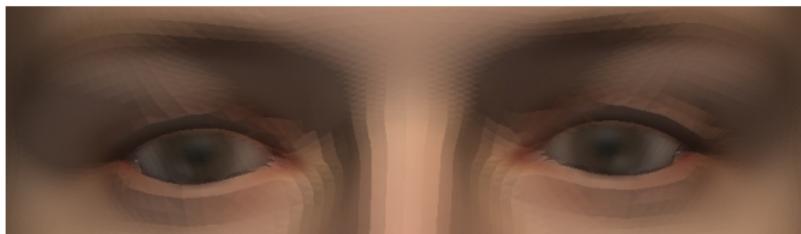
COMPARISON



COMPARISON - MOUTH



COMPARISON - EYES



COMPARISON - EARS

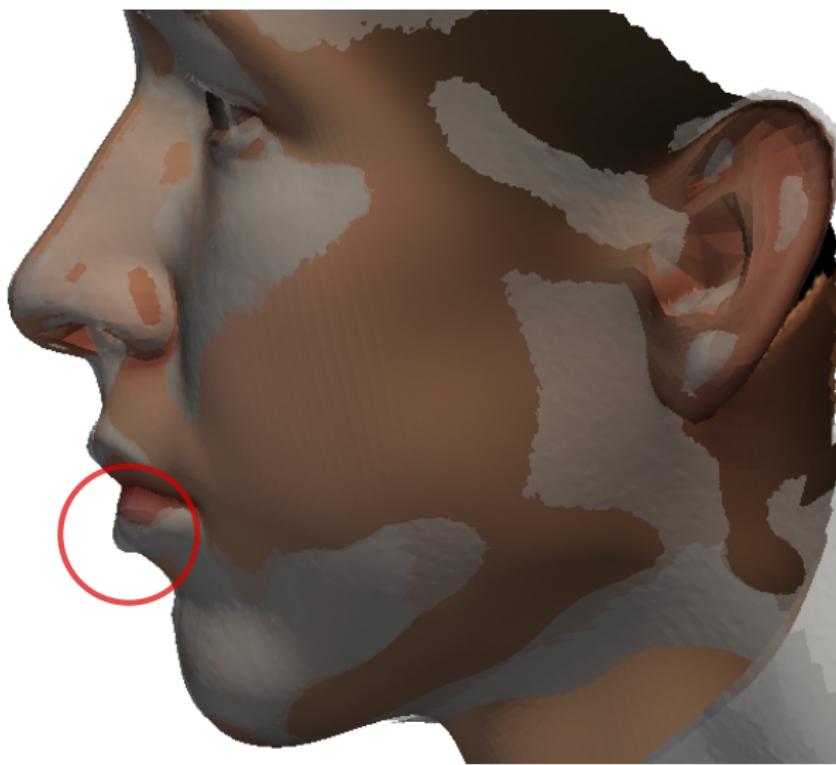


CARICATURES

video



EXPRESSIVENESS



CONCLUSION

- ▶ Incorporation of line features rendered good registration results
- ▶ Optimization process has to be further adapted for more expressiveness

FUTURE WORK

detect template regions corresponding to **holes** in target

detect template regions **missing** in target

by registering target on to template

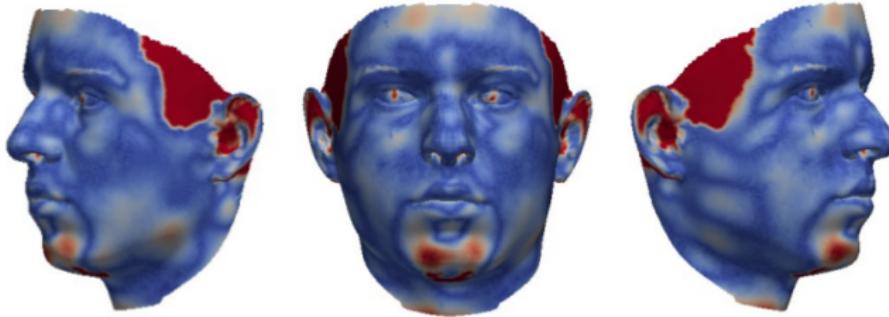
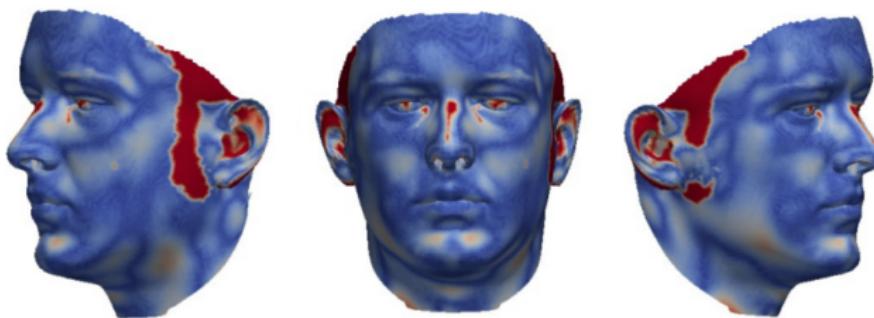
⇒ use Mean Squared Error to perform optimization without artifacts

THANK YOU FOR LISTENING!

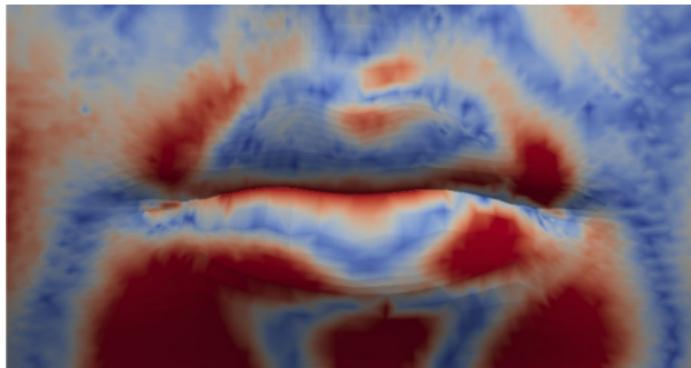
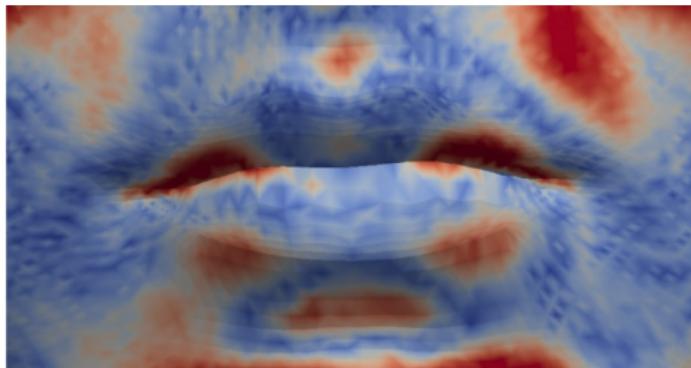
Any questions?



DISTANCE MEASURE



DISTANCE MEASURES - MOUTH



DISTANCE MEASURES - EYES

