Using Line Features for 3D Face Registration

BACHELOR THESIS PRESENTATION

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UNIVERSITÄT BASEL

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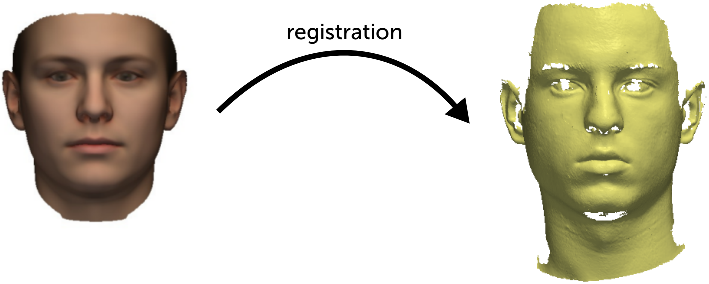
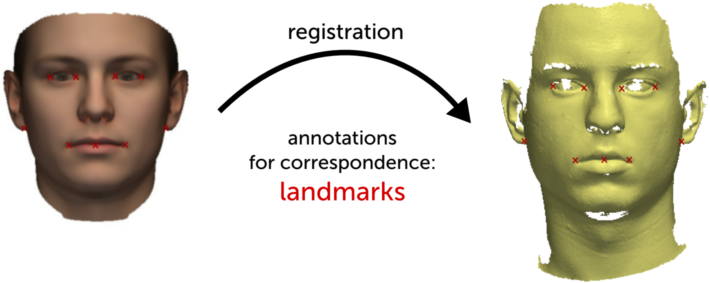
Registration Overview



Registration Overview



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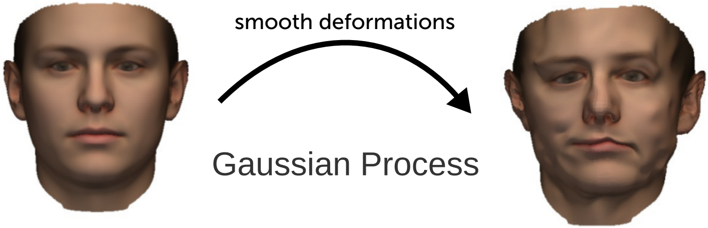

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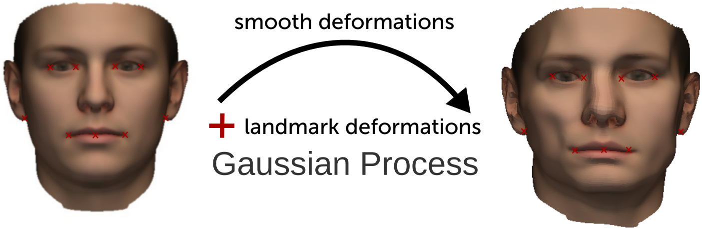

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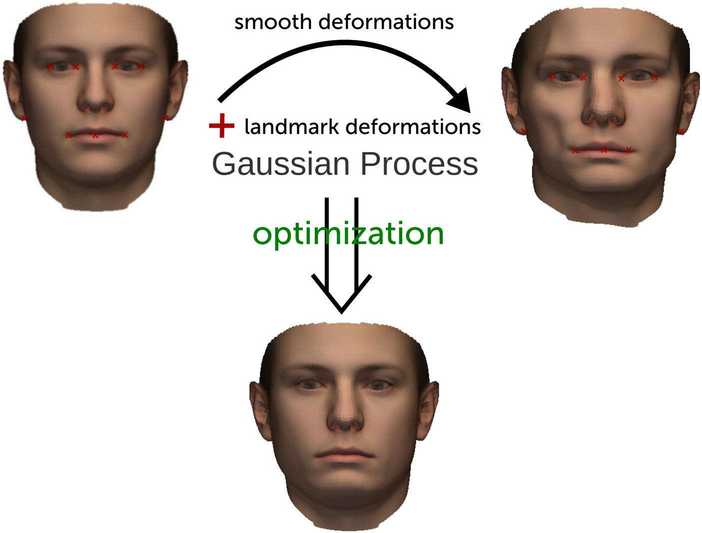

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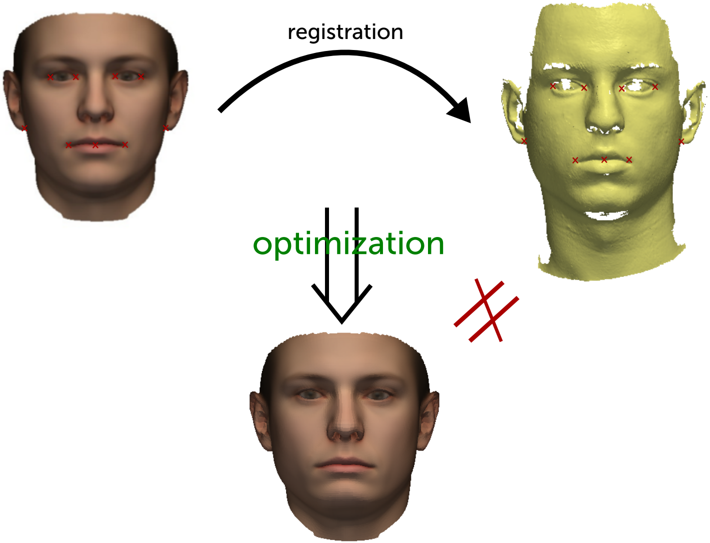

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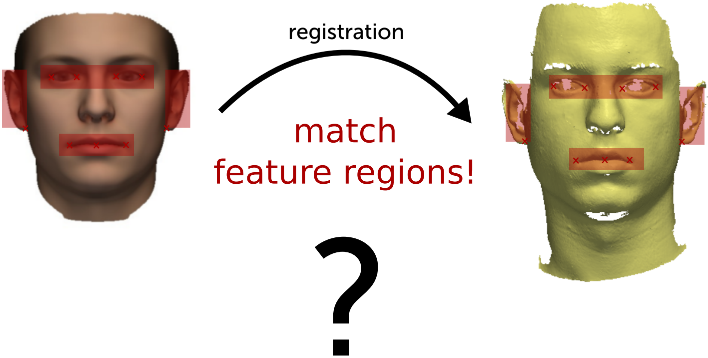
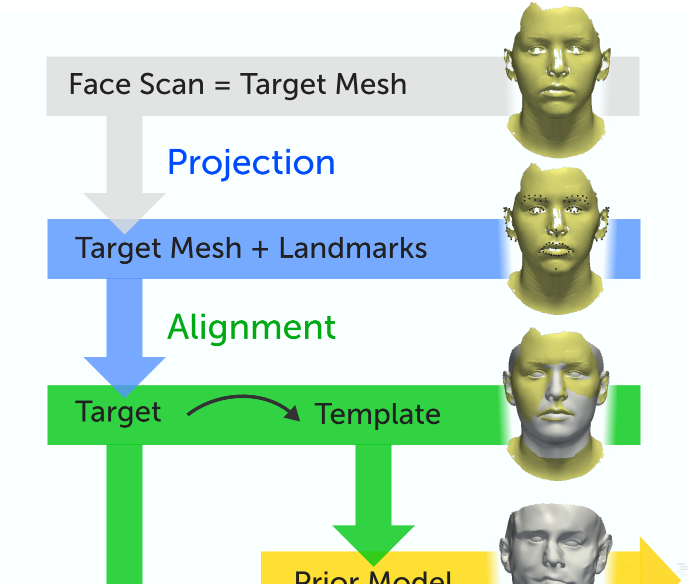
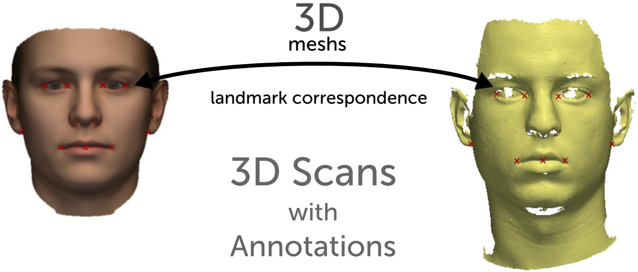


Pipeline


Face Scan = Target Mesh
Projection
Target Mesh + Landmarks
Alignment
Target
Template
Prior Model

Data and Correspondence



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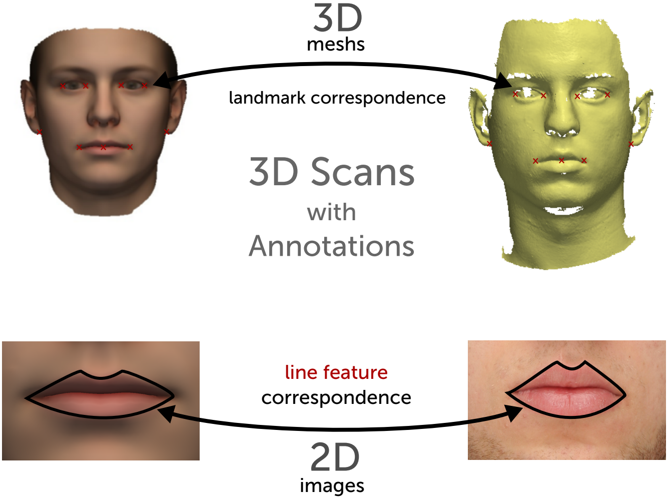

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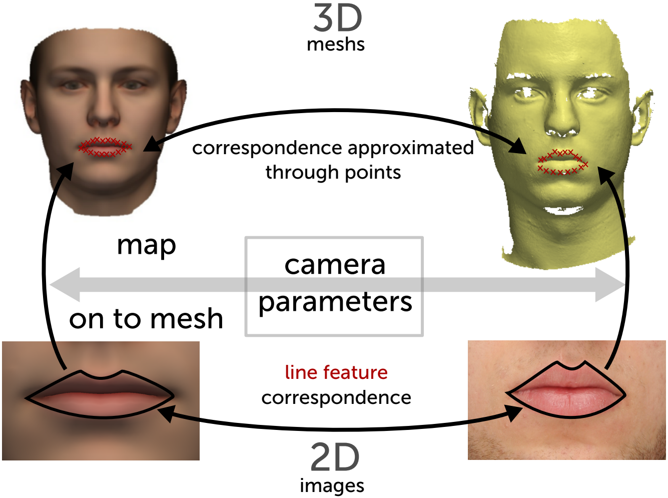
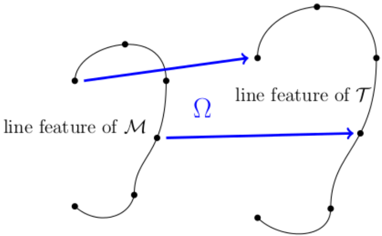
Data and Correspondence



Mapping Line Features

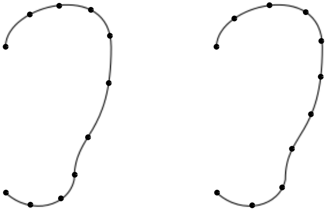
Idea: Sample points from the line features and use them as additional landmarks



What about correspondence?

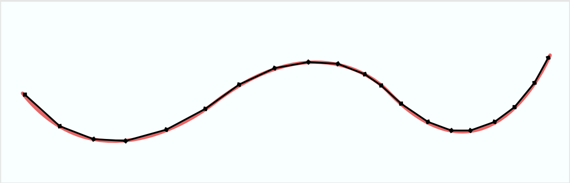
Equidistant Sampling

Approximate correspondance by sampling line features in equidistant intervals



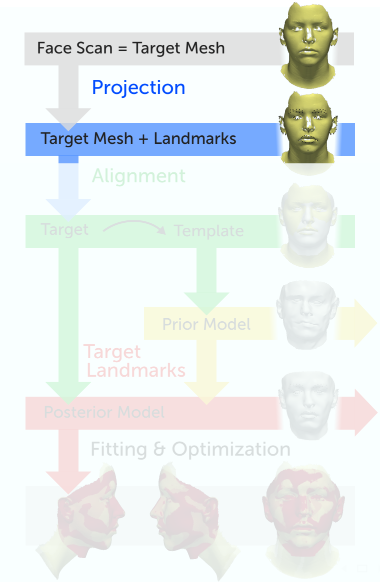
BÉZIER CURVES

Problem: Line features consist of Bézier curve segments
$\rightarrow$ underlying parameter t is not linear
Approximate arc-length of curve through euclidean distance of sampled points

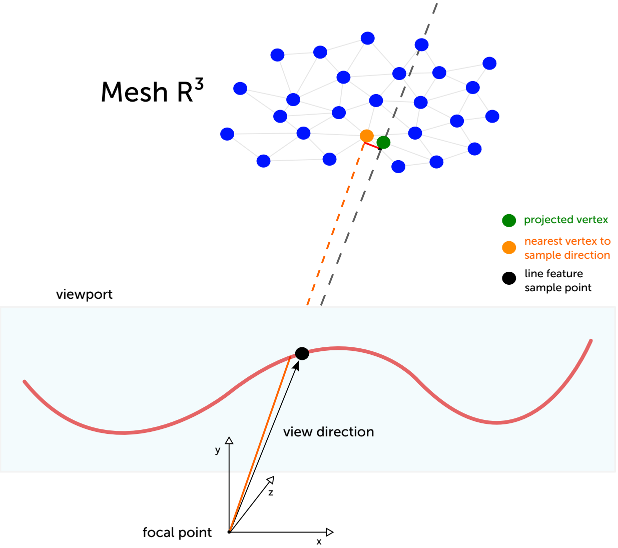


Rrightarrow map point coordinates to approximated fractional length of curve

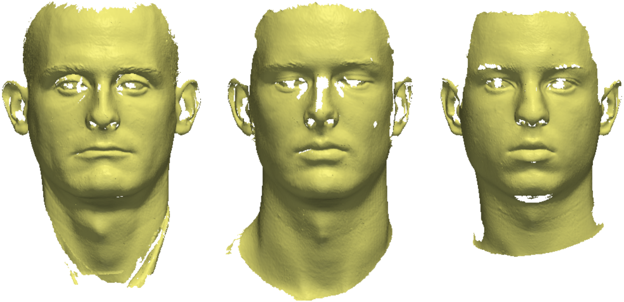
Pipeline: Projection



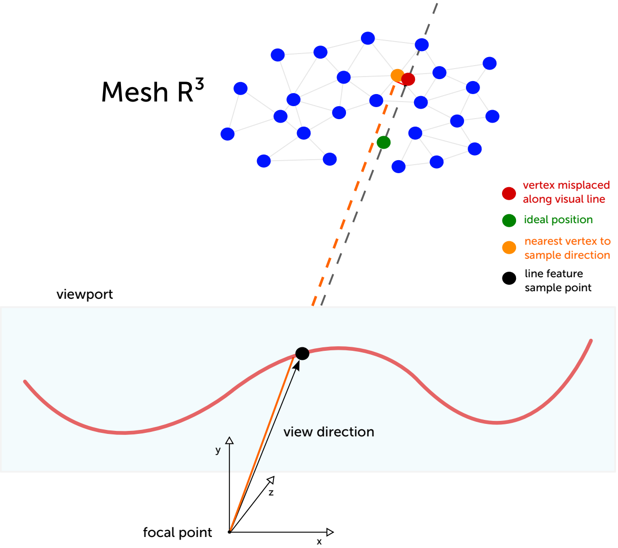
Projection: 2D to 3D



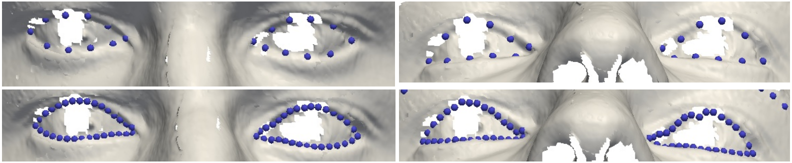
TARGET MESH HOLES



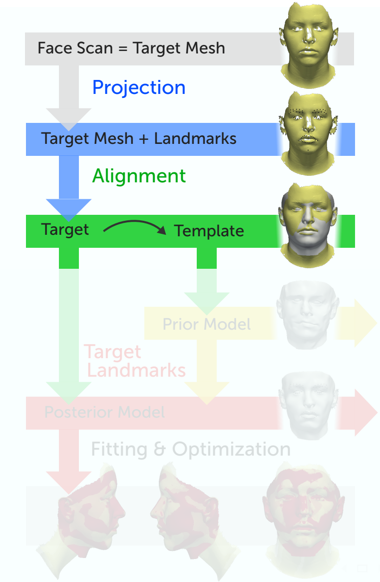
Projection: holes



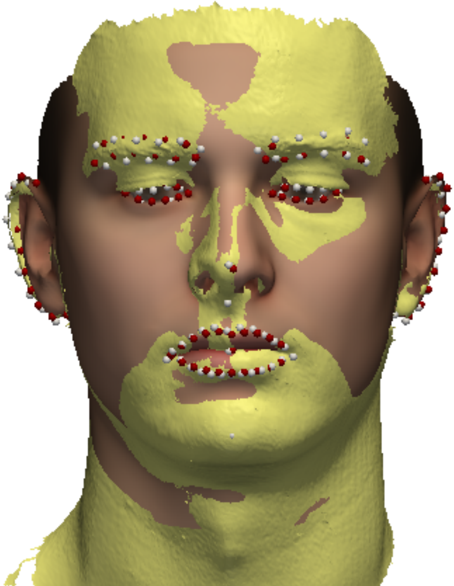
3D representation



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

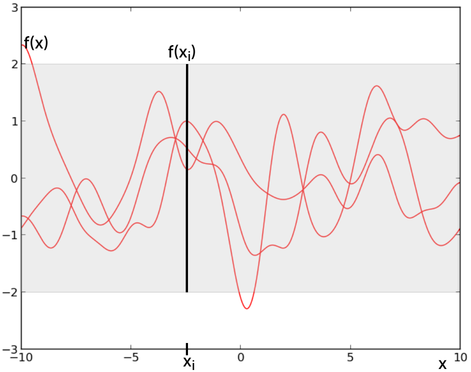


Figure: normal distribution over 1000 input points

GP Posterior Distribution

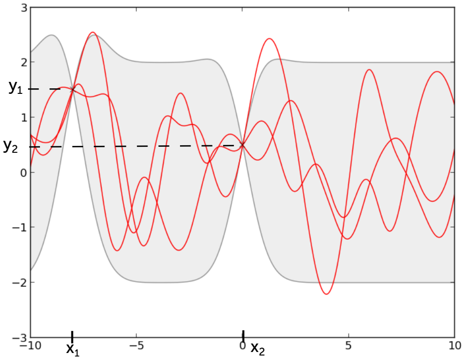


Figure: posterior distribution fixed at 2 input points

GP POSTERIOR DISTRIBUTION

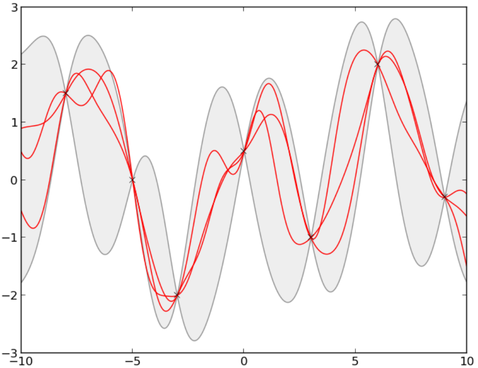


Figure: posterior distribution fixed at 7 input points

GPR IN 3D FACE REGISTRATION

definition of Vector-valued GP

$$\mu : \mathcal{M} \to \mathbb{R}^3$$

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

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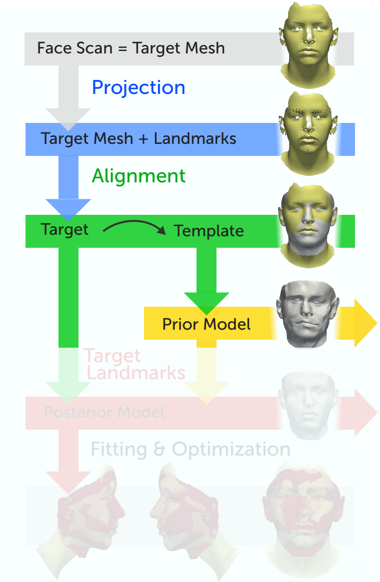
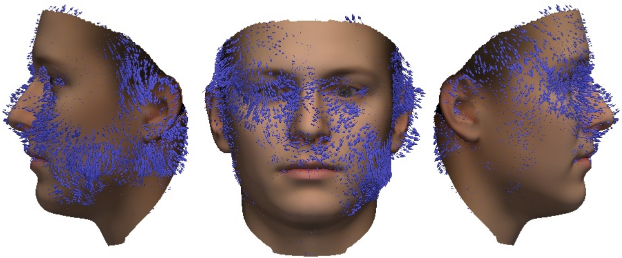
Pipeline: Deformation Prior



Deformation Prior

build GP Prior from template mesh vertices
$\rightarrow$ GP defines a distribution of possible deformations of the template



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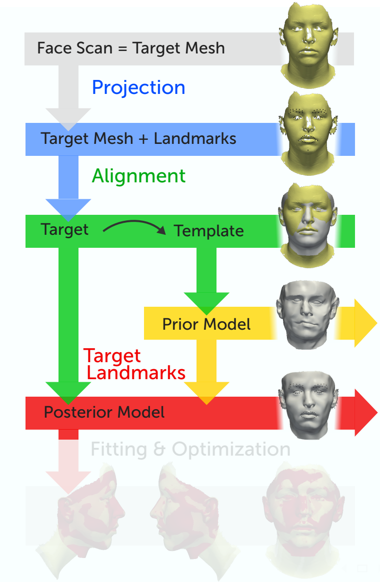
Prior faces

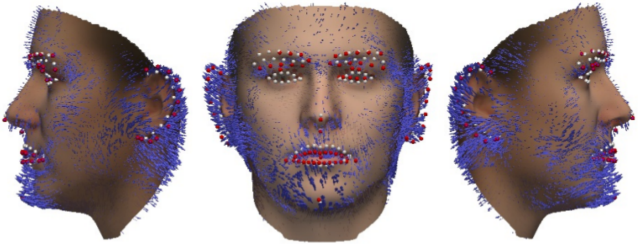
Pipeline: Deformation Posterior



3D GP Posterior

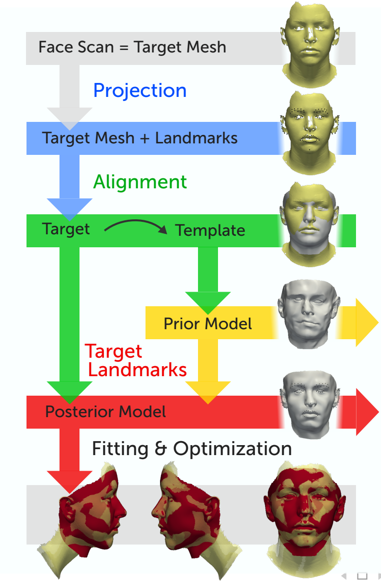
Training data for inference in the space of possible template surface deformations:
comprised of the residuals of the line feature sample coordinates

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



Posterior Meshs

Fitting & Optimization



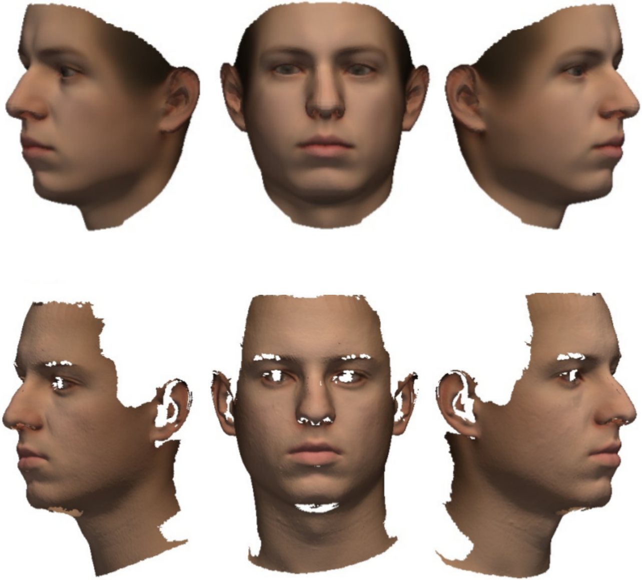
Parametric Model

GP Posterior distribution of admissible deformations
How to optimize deformation samples?

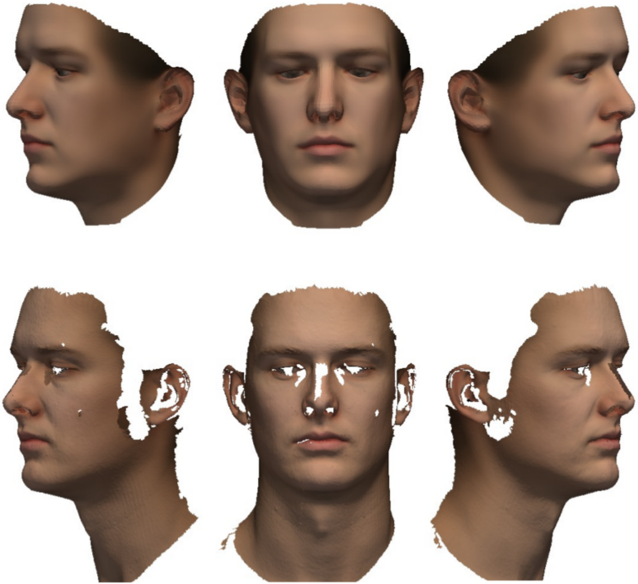
Mercer's theorem: distribution $\rightarrow$ parametric model
$\Rightarrow$ optimize model parameters

Mean Squared Error

Robust Estimator



Robust Estimator



Results - Mouth

Results - Eyes

Results - Ears

Caricatures

hi

Future Work

detect “outlier regions” - template regions corresponding to holes in target
by registering target on to template
$\Rightarrow$ use Mean Squared Error to perform optimization without artifacts

Thank you for listening!

Any questions?