

Learning a model of facial shape and expression from 4D scans

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MAX-PLANCK-GESELLSCHAFT



SIGGRAPH Asia 2017

Note: this slide is a static .pdf version (no video)
For video, please see: <https://youtu.be/36rPTkhijTM>

Realistic Virtual Character

Warner Bros. &
Paramount Pictures



Warner Bros. &
Paramount Pictures



Consumer Application

Apple 2017



Spectrum of Face Models

“Low-end”

“High-end”



Spectrum of Face Models



“Low-end”

FACS-based blendshapes

“High-end”



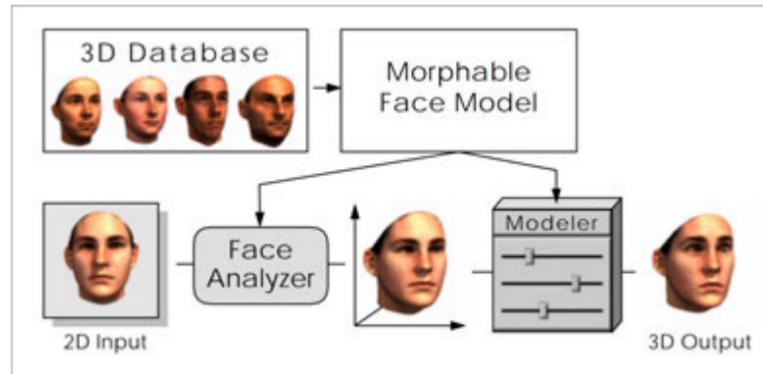
Spectrum of Face Models



“Low-end”

FACS-based blendshapes

“High-end”



Blanz and Vetter 1999

& Basel Face Model
[Paysan et al. 2009]

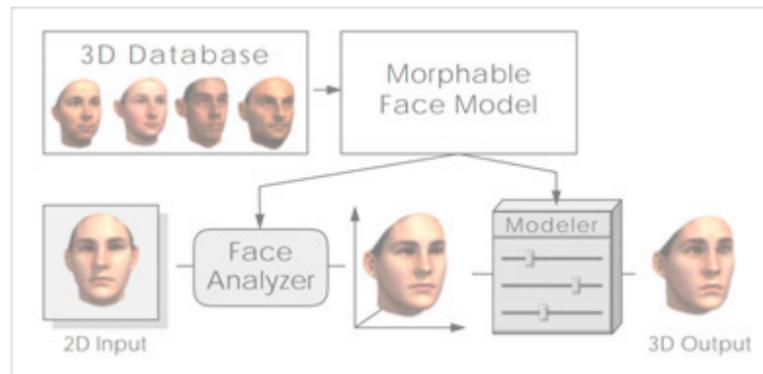
Spectrum of Face Models



FACS-based blendshapes

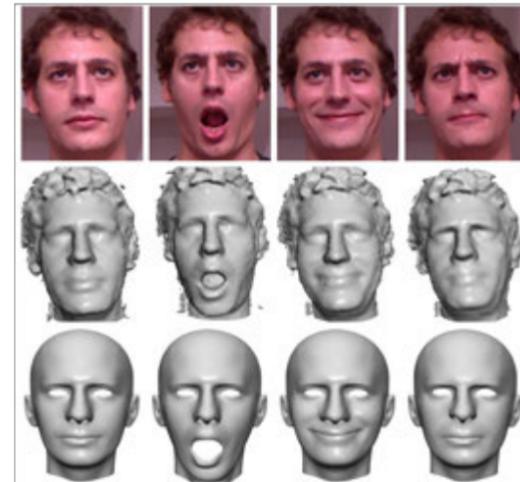
“Low-end”

“High-end”



Blanz and Vetter 1999

& Basel Face Model
[Paysan et al. 2009]

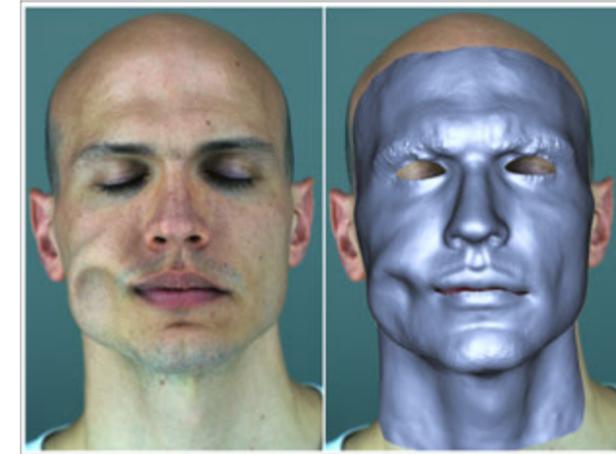


FaceWarehouse
[Cao et al. 2014]

Spectrum of Face Models



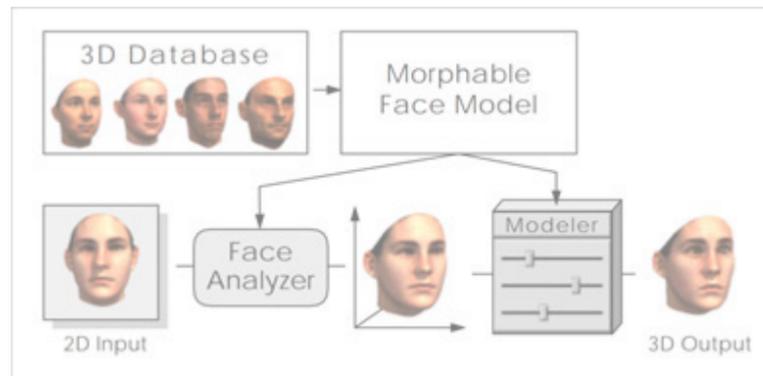
FACS-based blendshapes



Wu et al. 2016

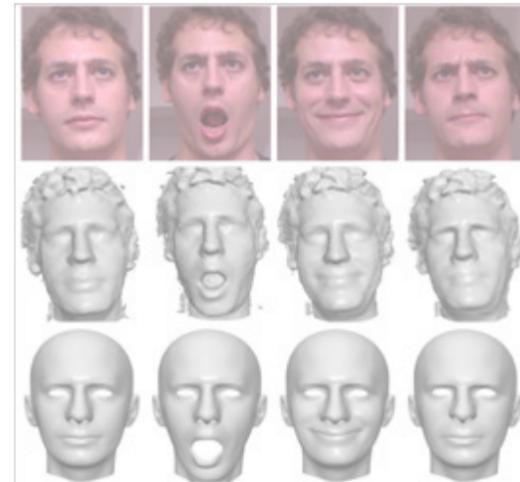
“High-end”

“Low-end”



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& Basel Face Model
[Paysan et al. 2009]



FaceWarehouse
[Cao et al. 2014]

Spectrum of Face Models



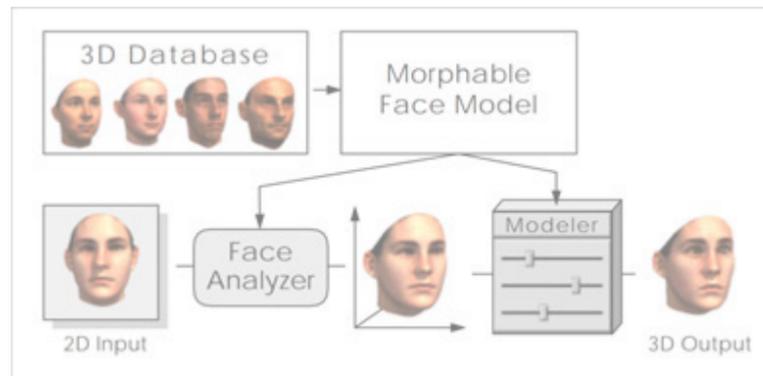
“Low-end”

FACS-based blendshapes

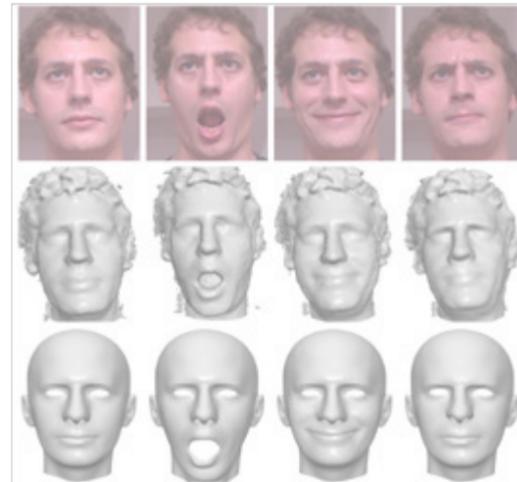


Wu et al. 2016

“High-end”



Blanz and Vetter 1999
& Basel Face Model
[Paysan et al. 2009]



FaceWarehouse
[Cao et al. 2014]



Digital Emily
[Alexander et al. 2009]

Spectrum of Face Models

“Low-end”

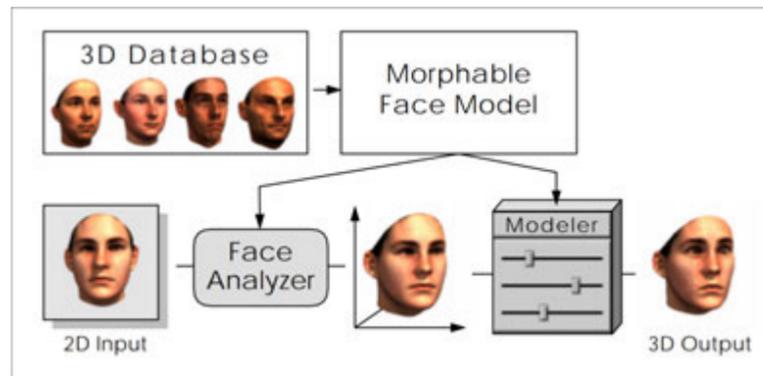


FACS-based blendshapes

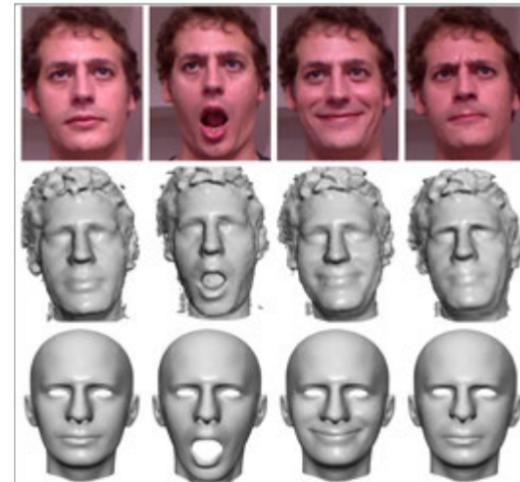


Wu et al. 2016

“High-end”



Blanz and Vetter 1999
& Basel Face Model
[Paysan et al. 2009]



FaceWarehouse
[Cao et al. 2014]



Digital Emily
[Alexander et al. 2009]

FLAME Face Model

Issues

FLAME

FLAME Face Model

Issues

Limited identity coverage

FLAME

Learned from ~4000 identities

FLAME Face Model

Issues

Limited identity coverage

Artist designed expression

FLAME

Learned from ~4000 identities

Learned from high-quality 4D expression scans

FLAME Face Model

Issues

Limited identity coverage

Artist designed expression

Over-complete FACS basis

FLAME

Learned from ~4000 identities

Learned from high-quality 4D expression scans

Orthogonal expression space

FLAME Face Model

Issues

Limited identity coverage

Artist designed expression

Over-complete FACS basis

Non-linearity of jaw and neck

FLAME

Learned from ~4000 identities

Learned from high-quality 4D expression scans

Orthogonal expression space

Modeled as rotatable joints

Activated by linear blend skinning

Pose blendshapes further capture details

FLAME Face Model

Issues

Limited identity coverage

Artist designed expression

Over-complete FACS basis

Non-linearity of jaw and neck

Require artist work

FLAME

Learned from ~4000 identities

Learned from high-quality 4D expression scans

Orthogonal expression space

Modeled as rotatable joints

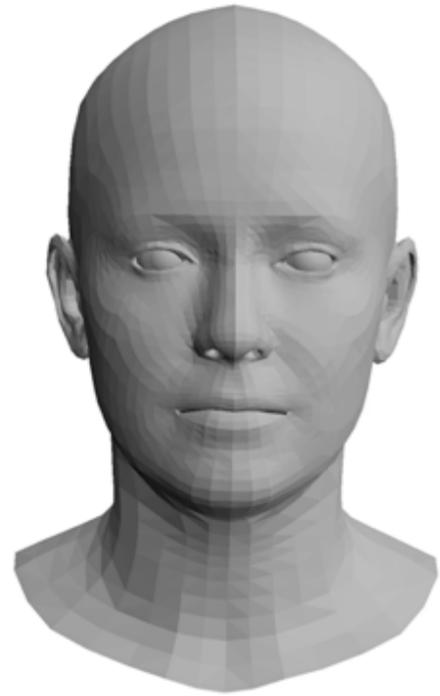
Activated by linear blend skinning

Pose blendshapes further capture details

Fully automatic registration and modeling

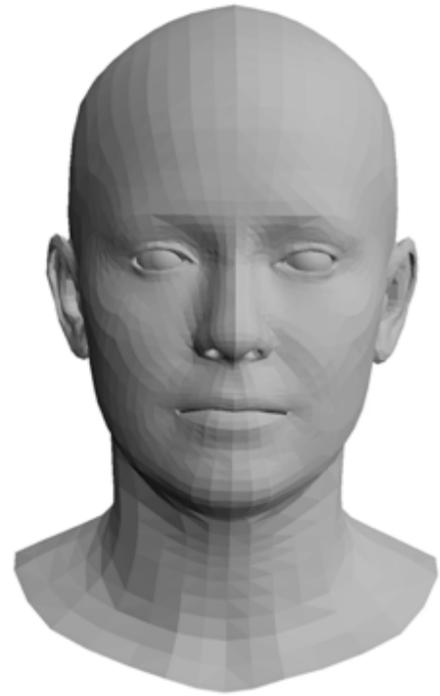
FLAME Face Model

FLAME Face Model

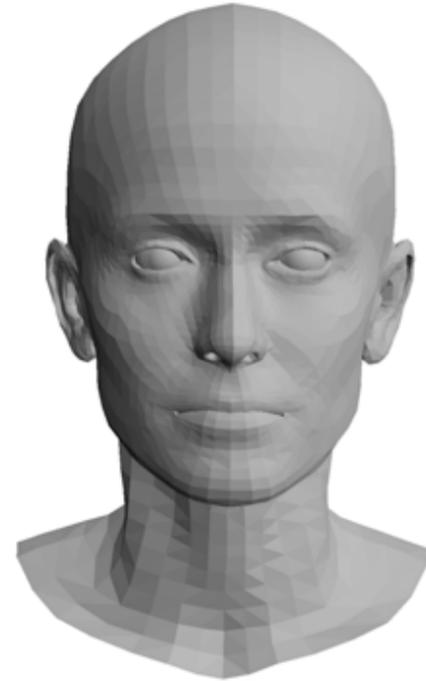


Template

FLAME Face Model

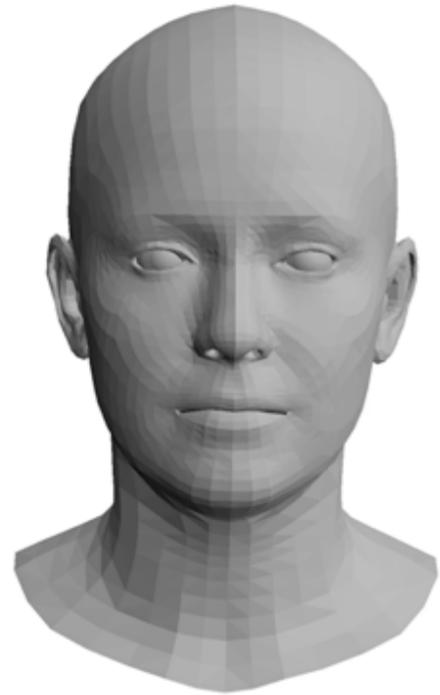


Template

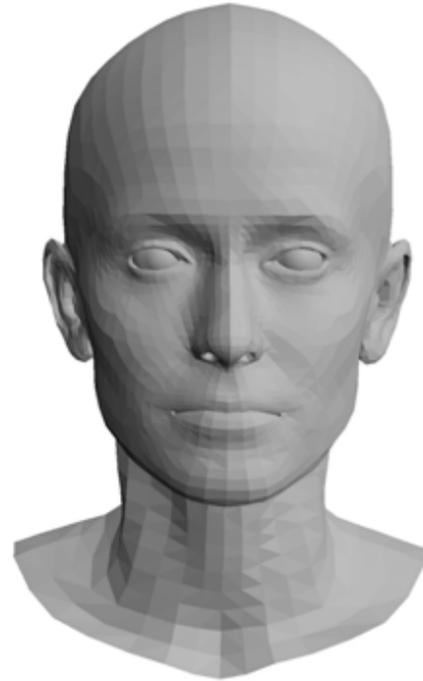


Shape

FLAME Face Model



Template

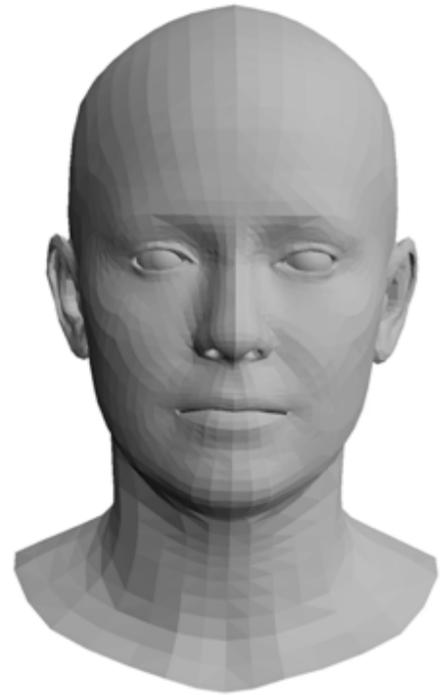


Shape

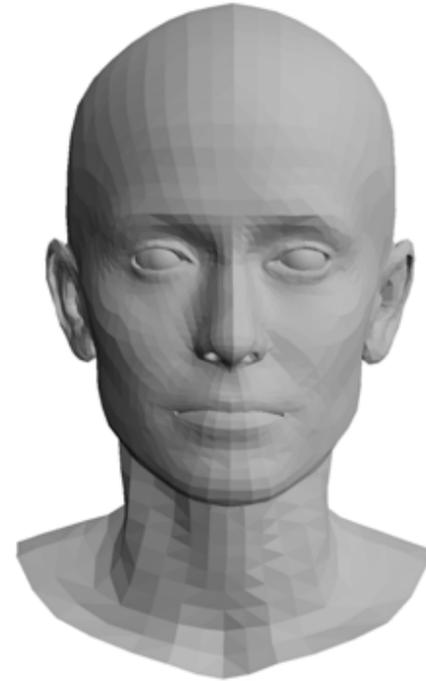


Shape
+Pose

FLAME Face Model



Template



Shape

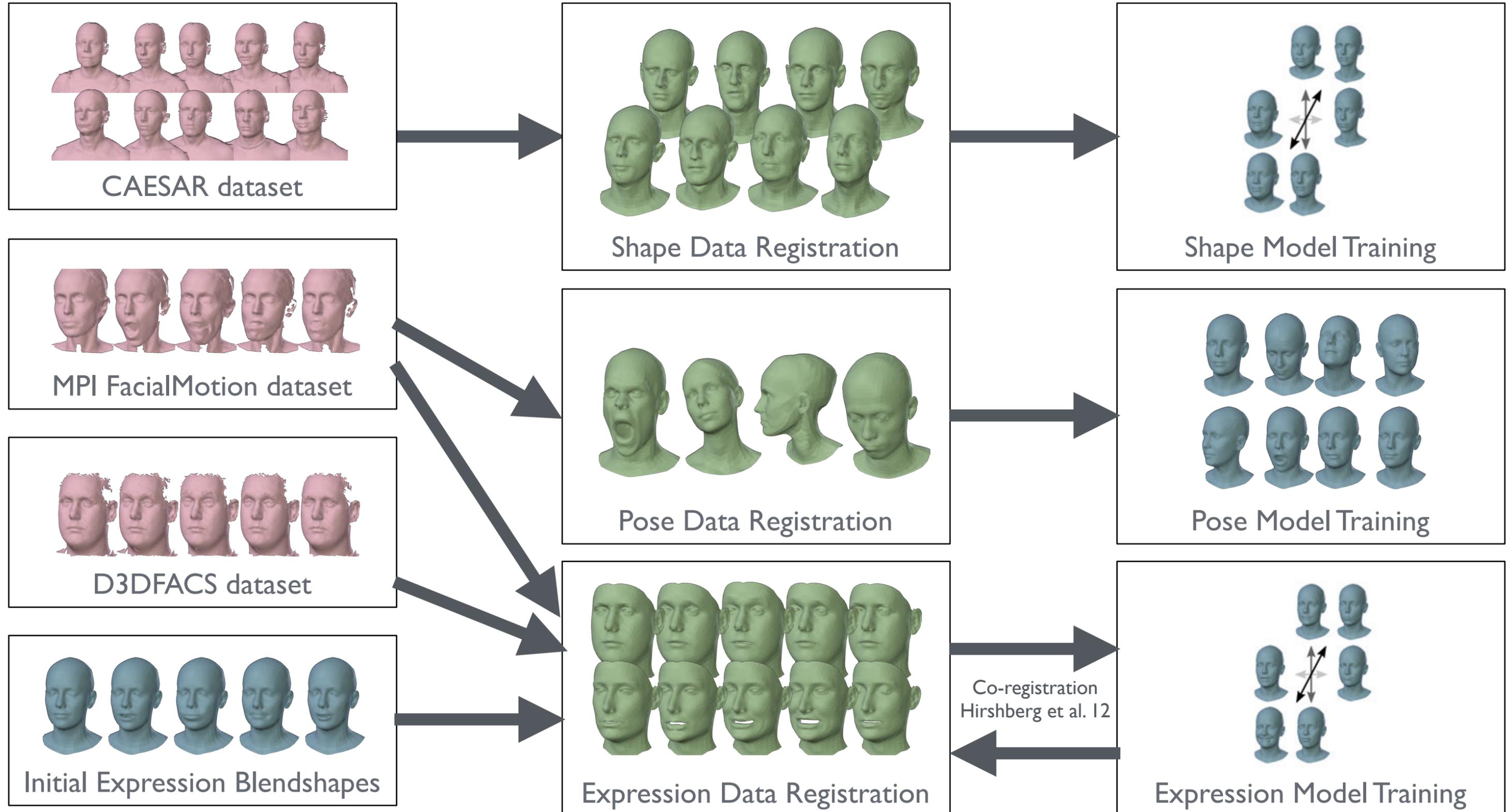


Shape
+ Pose

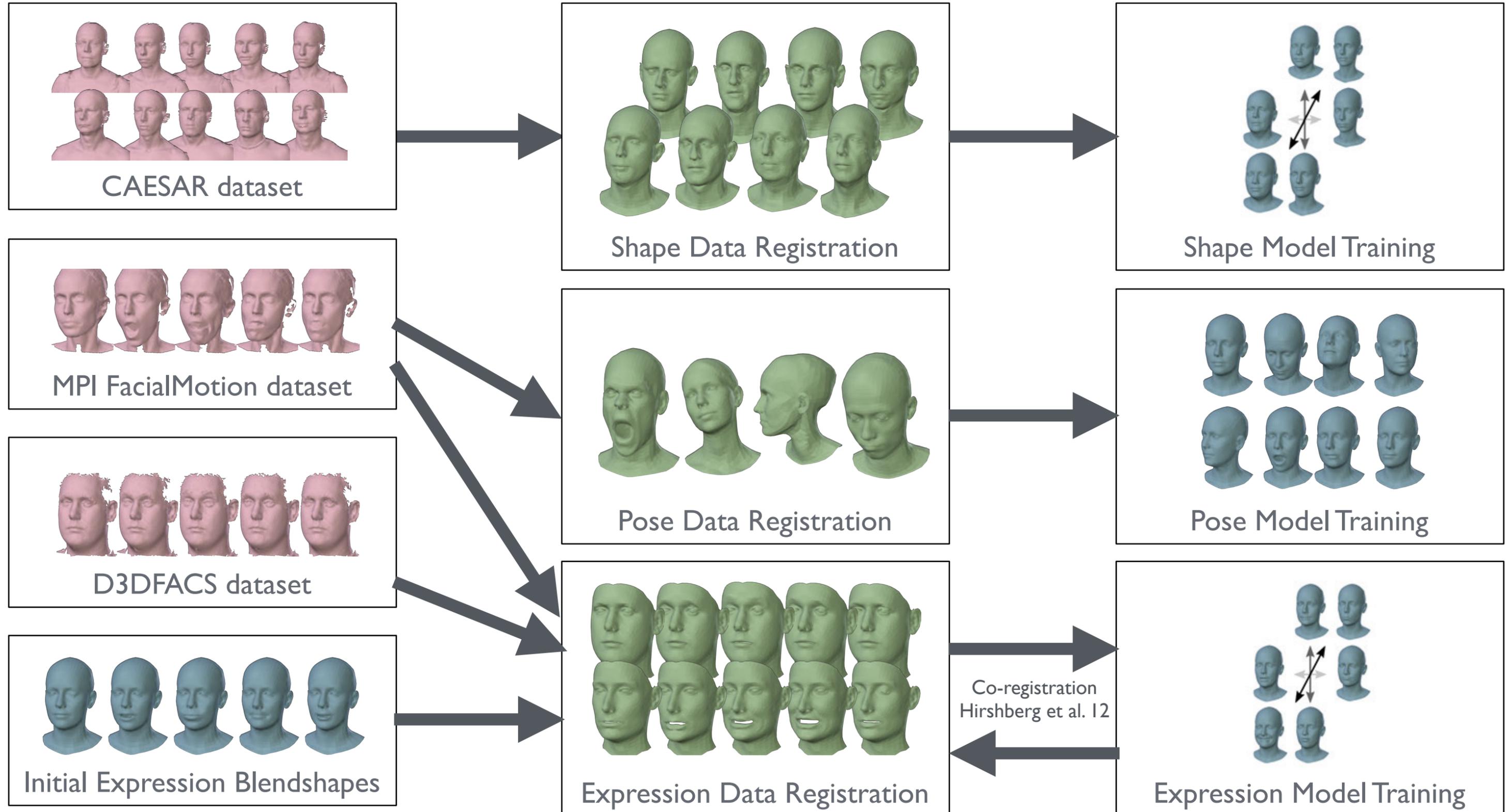


Shape
+ Pose
+ Expression

Overview



Overview



Shape Model

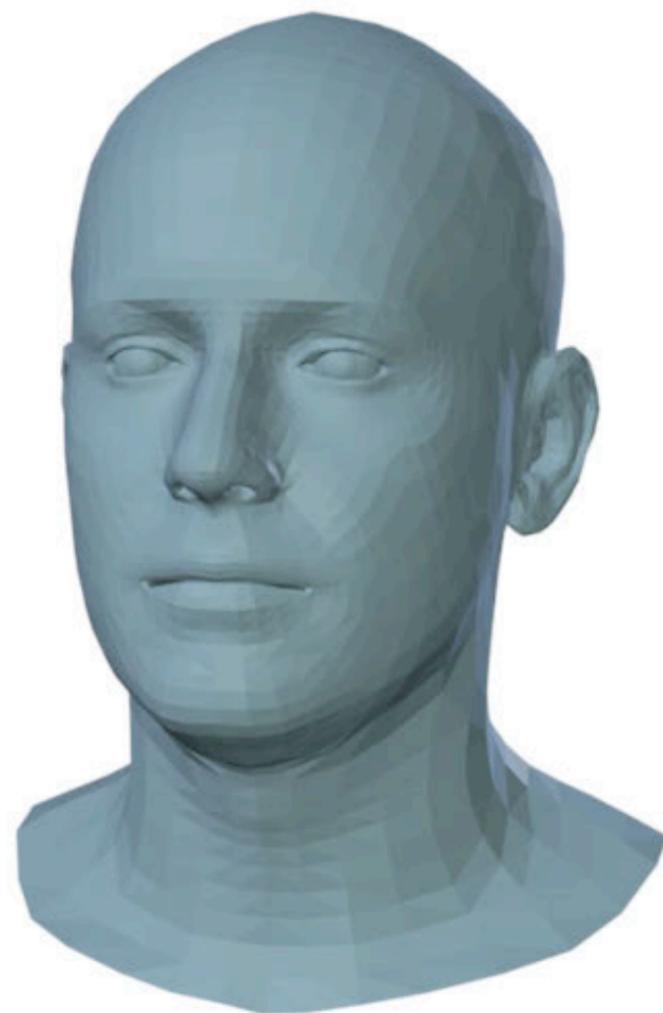
Shape Data



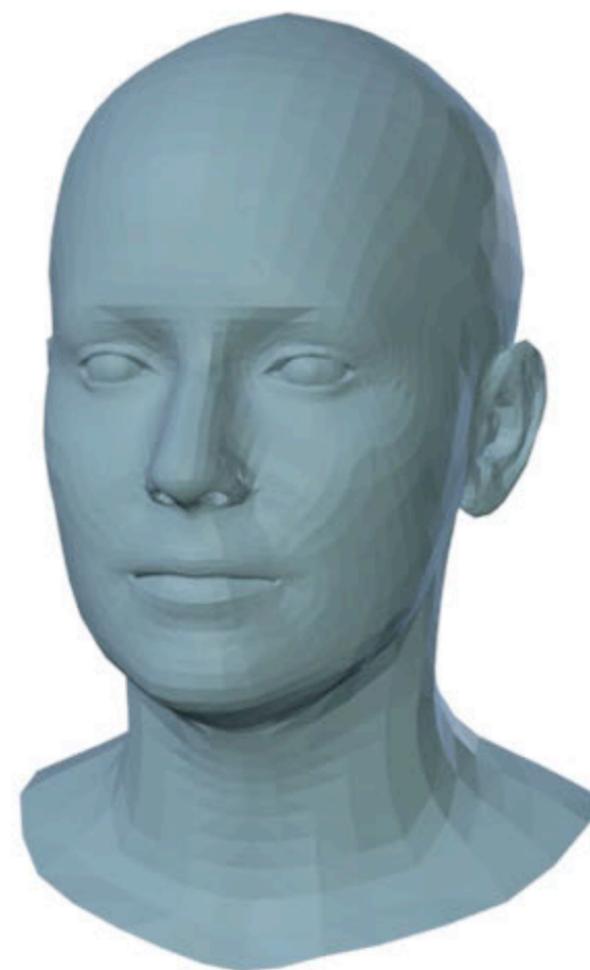
Registration of CAESAR datasets
[Robinette et al. 2002]

Learned Shape Model

PC #1
between +/- 3 std



male model



female model

Pose Model

Pose Data



Registration of MPI FacialMotion datasets for pose training

Learned Pose Model

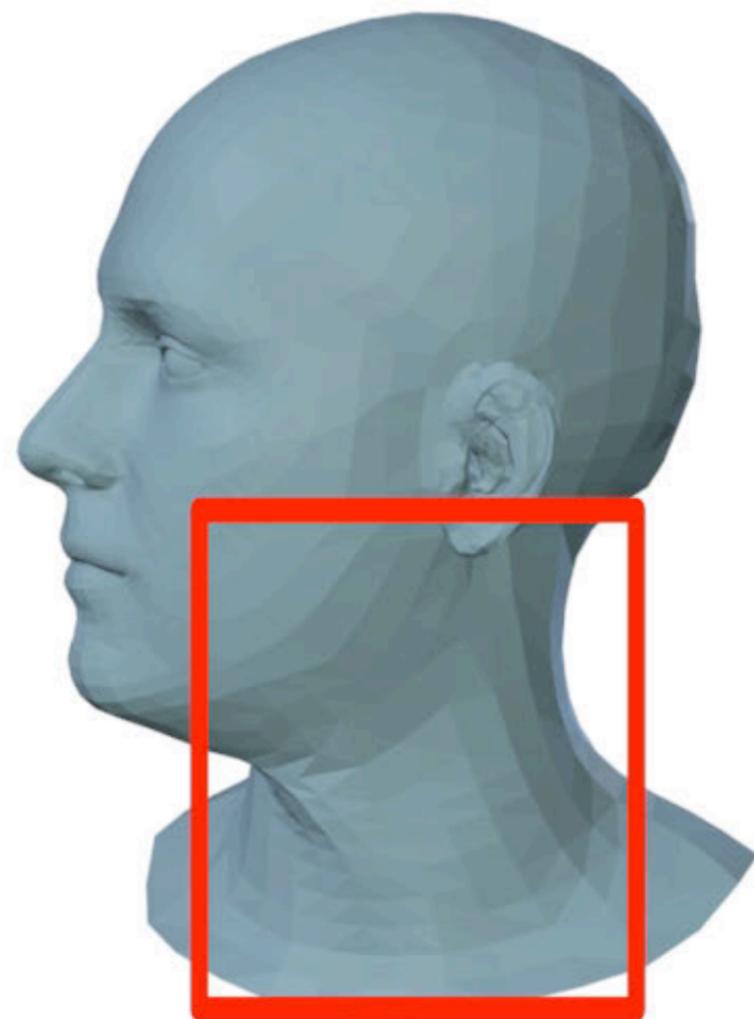


male model

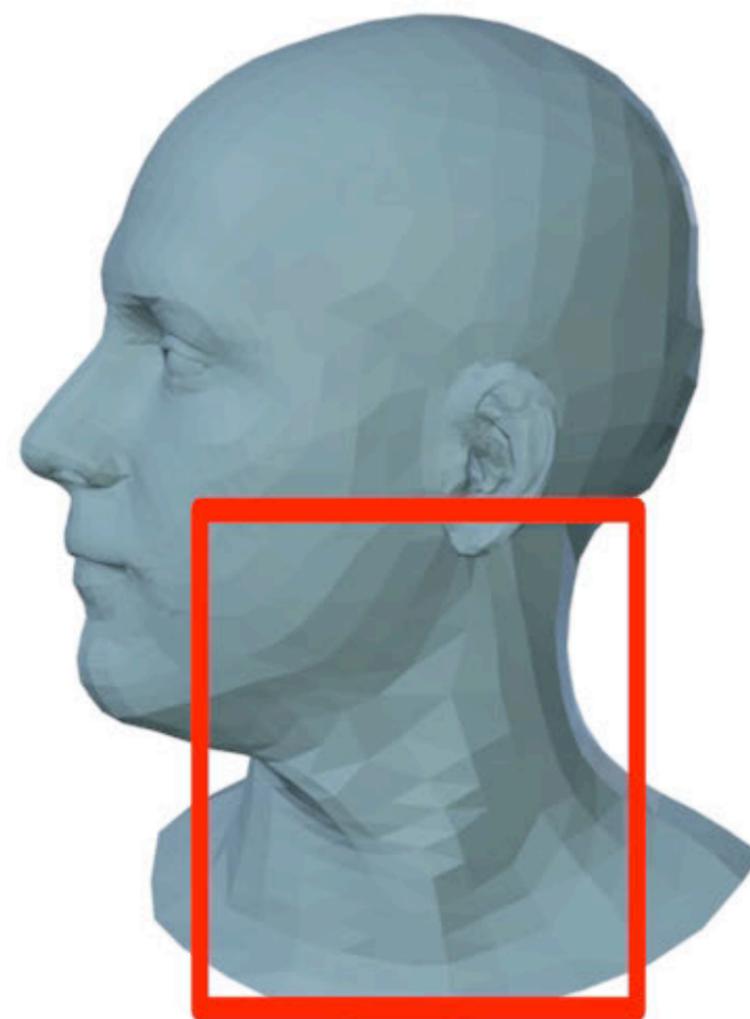


female model

Effect of Pose Blendshapes



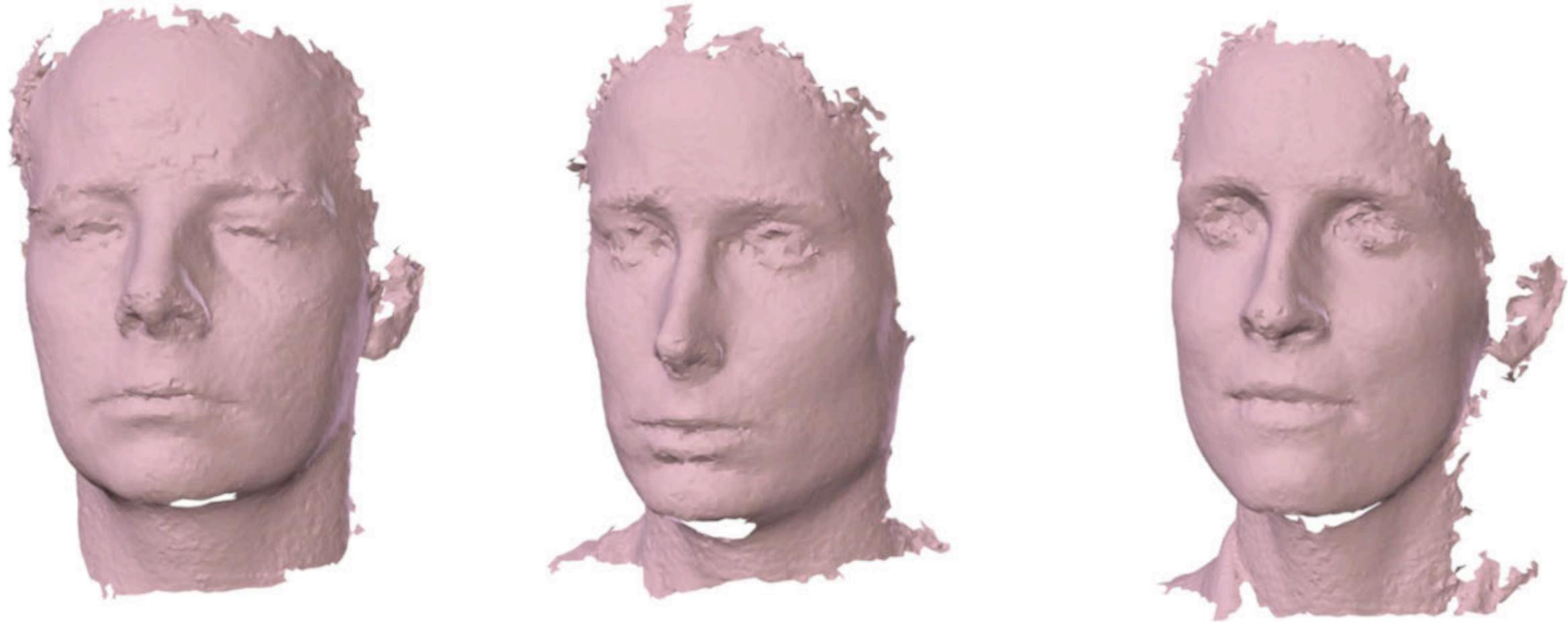
without
pose blendshape



with
pose blendshape

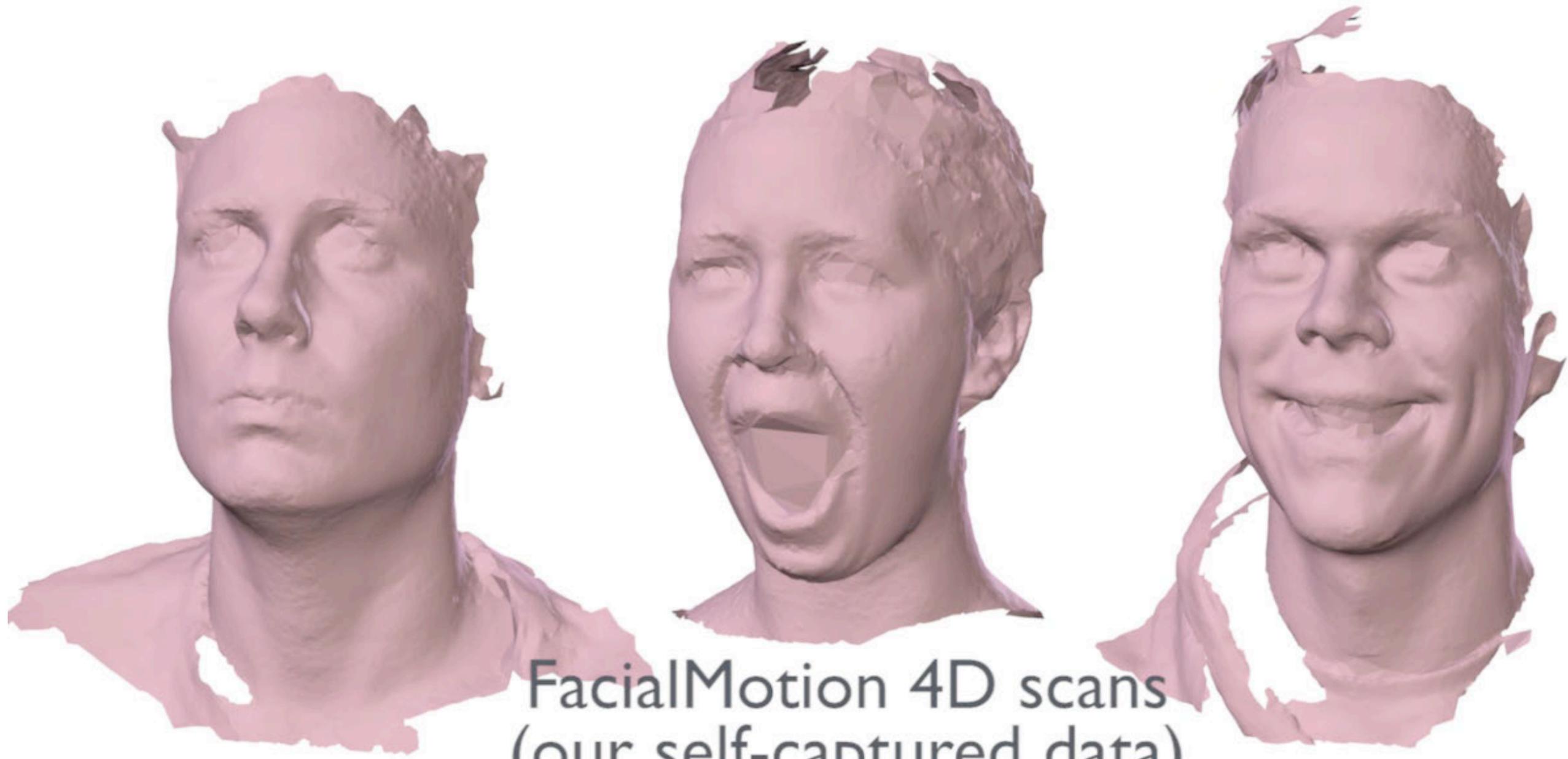
Expression Model

Expression Data



D3DFACS 4D scans
[Cosker et al. 2011]

Expression Data

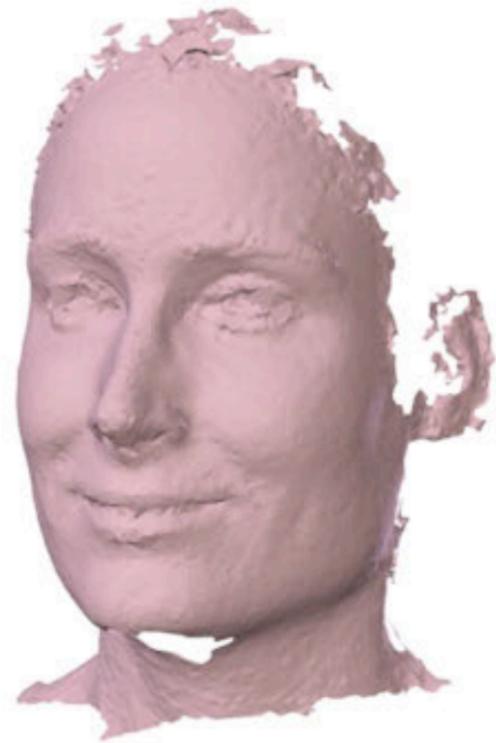


FacialMotion 4D scans
(our self-captured data)

4D Scans into Correspondence



Coarse-to-Fine Registration



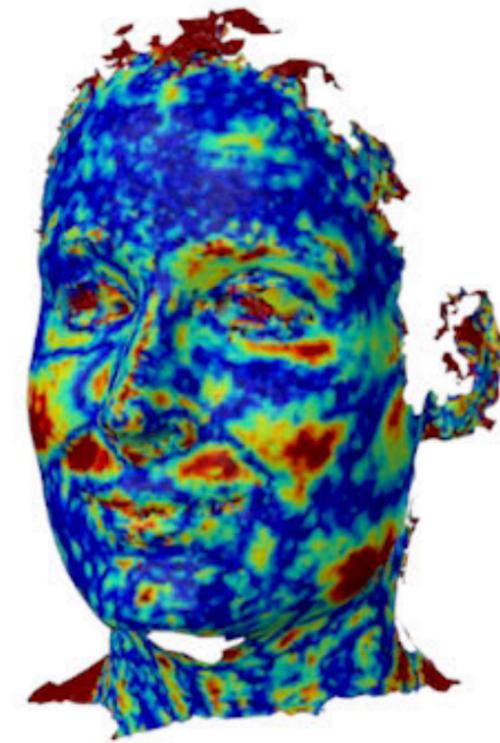
Scan



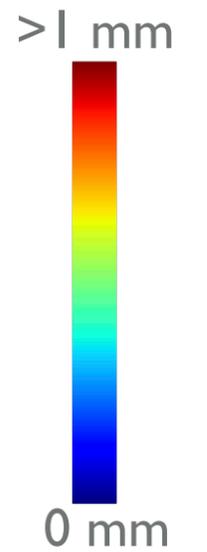
Registration



Overlay

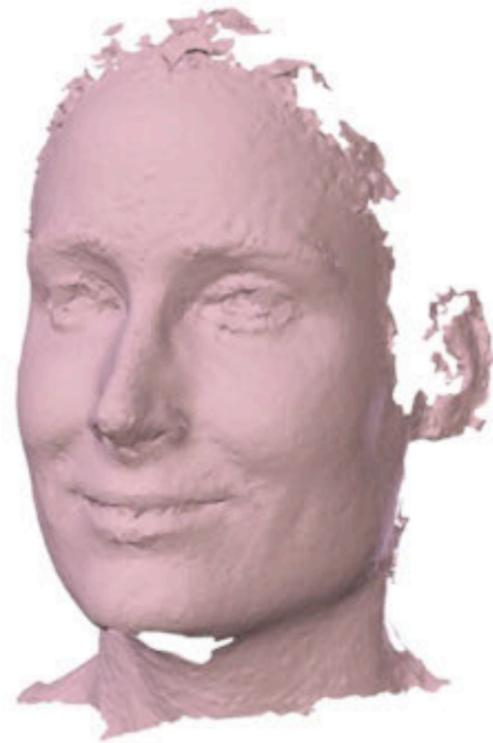


Scan-to-Mesh
Distance



Stage I: model-only

Coarse-to-Fine Registration



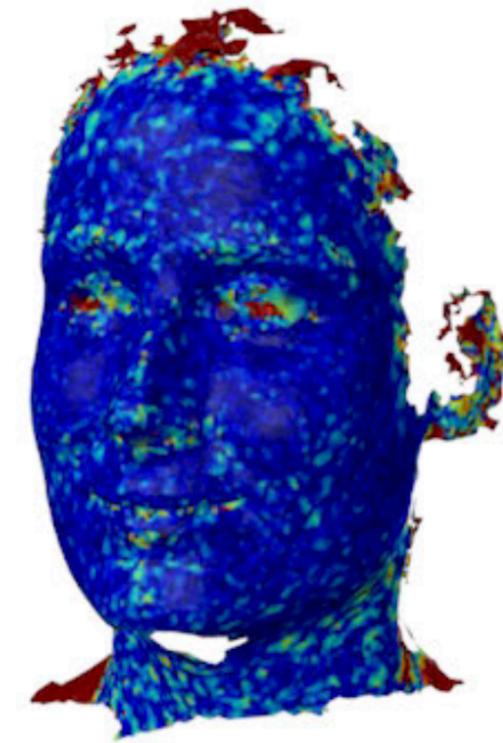
Scan



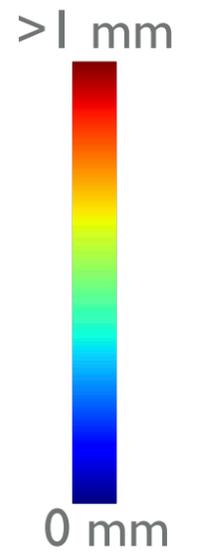
Registration



Overlay

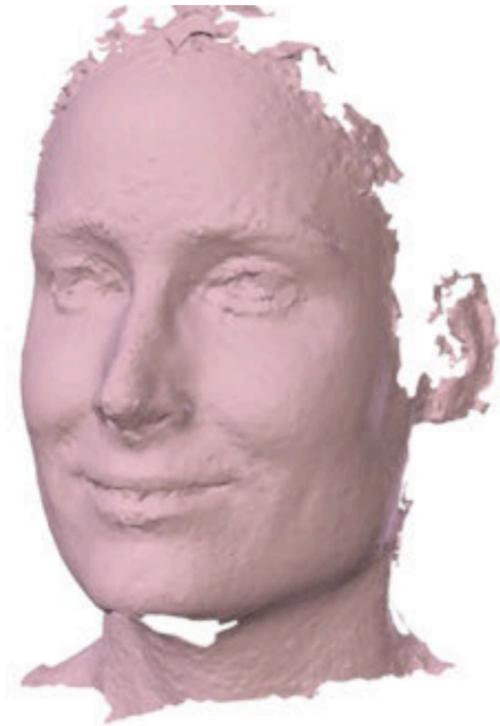


Scan-to-Mesh
Distance



Stage2: coupled

Coarse-to-Fine Registration



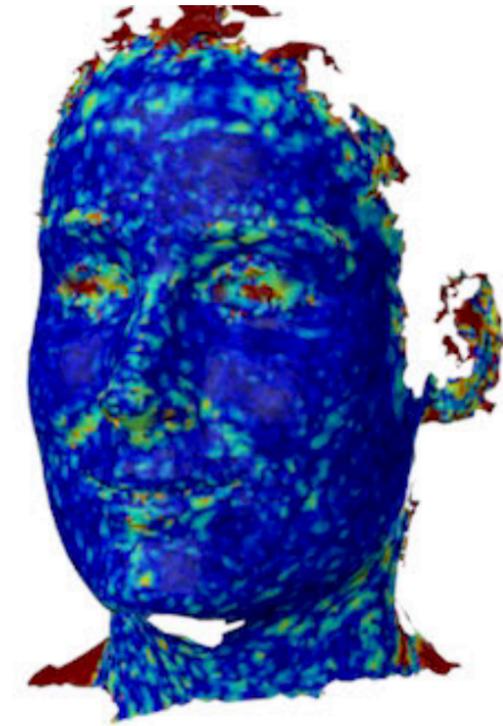
Scan



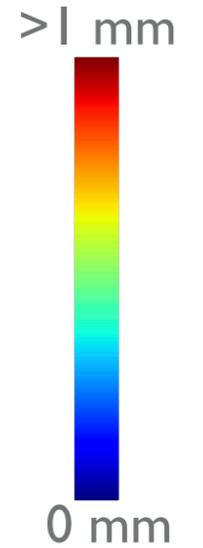
Registration
Input Image



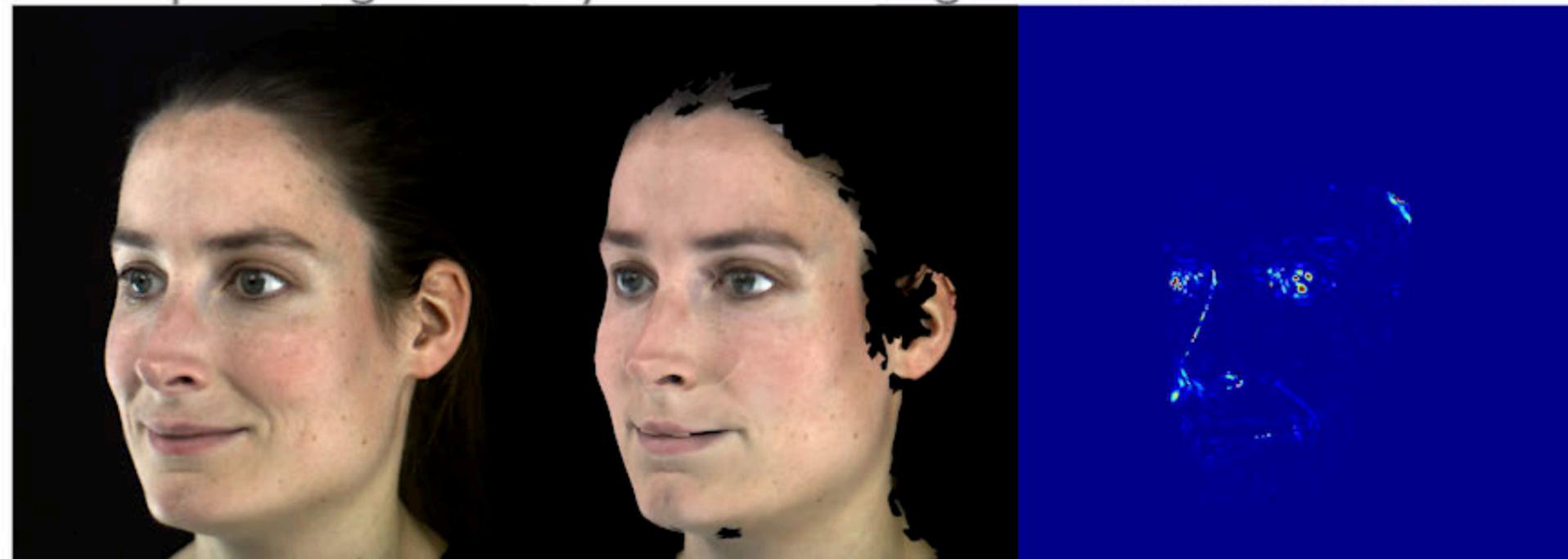
Overlay
Synthesized Image



Scan-to-Mesh Distance
Photometric Error



Stage 3:
Texture-based
Alignment



Effect of Texture-based Alignment



Input Image



Synthesized Image



Photometric Error

Without Texture-based Alignment

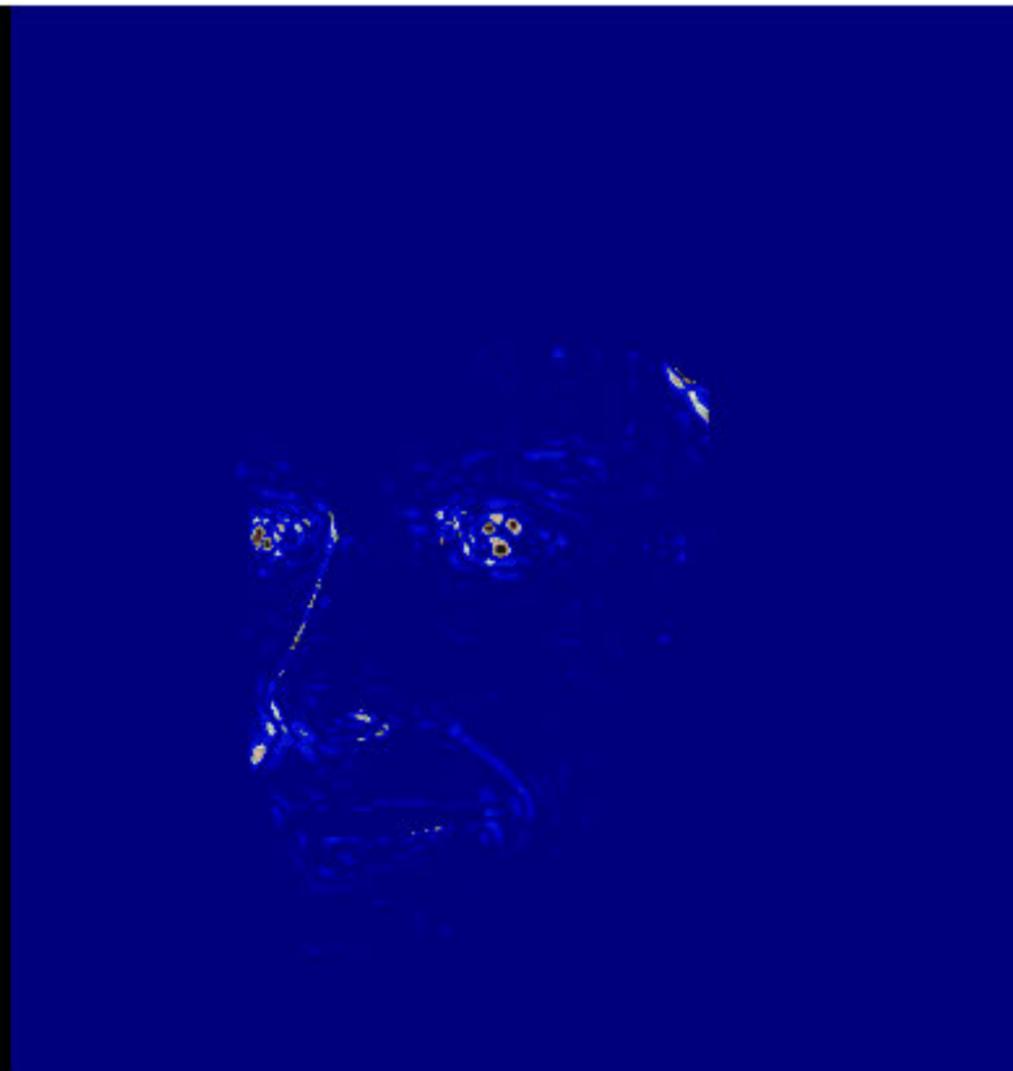
Effect of Texture-based Alignment



Input Image



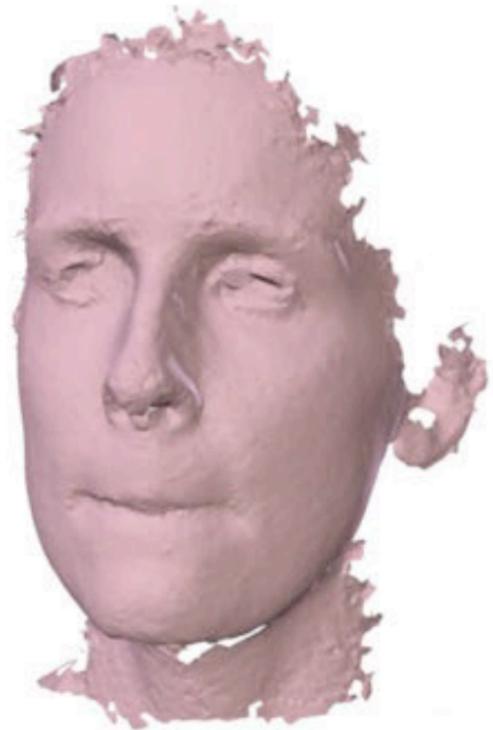
Synthesized Image



Photometric Error

With Texture-based Alignment

Registration Results



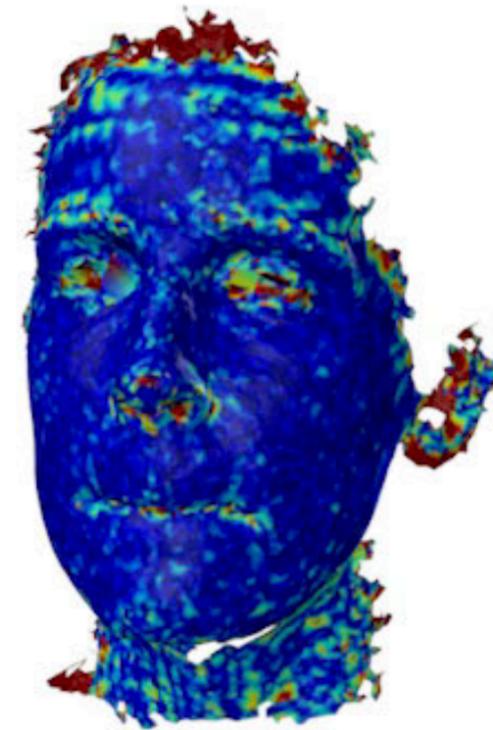
Scan



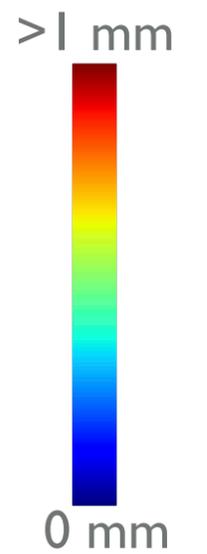
Registration



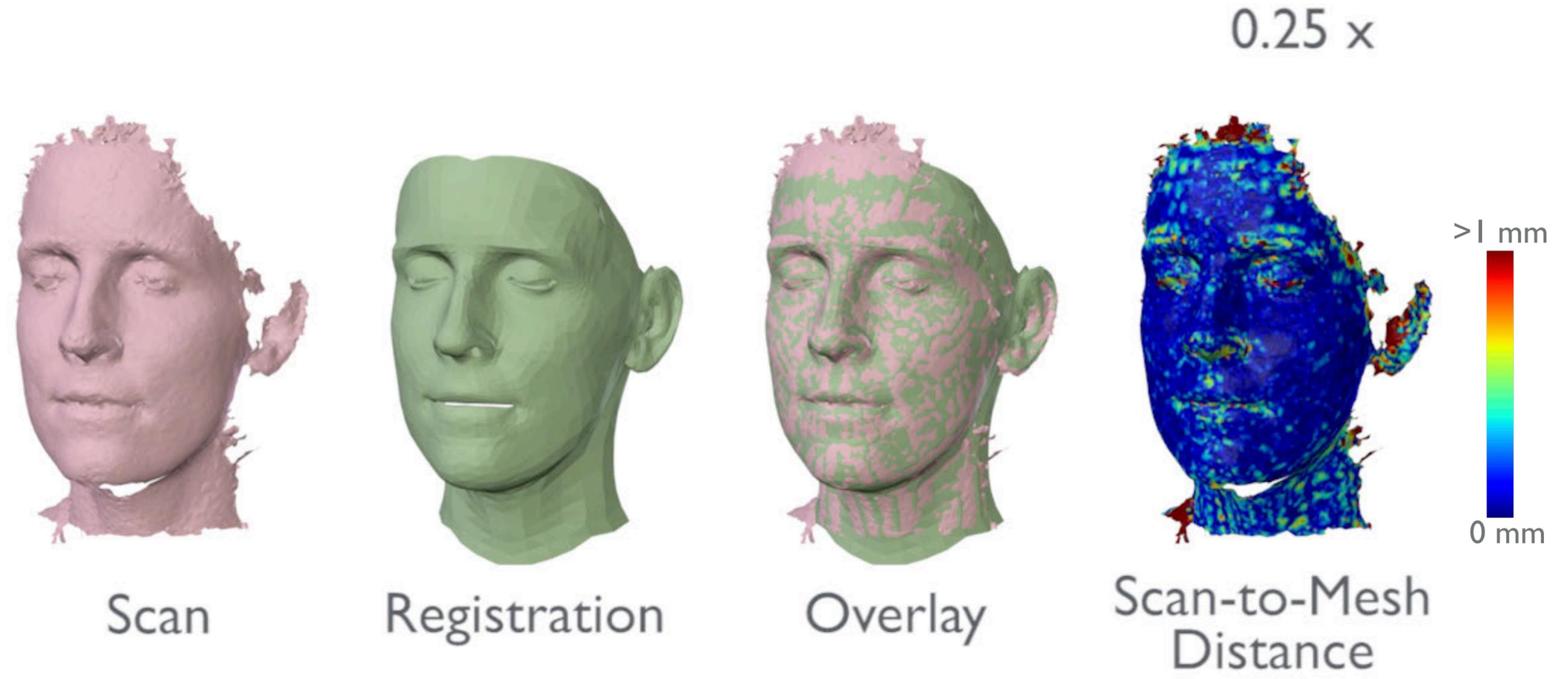
Overlay



Scan-to-Mesh
Distance



Registration Results



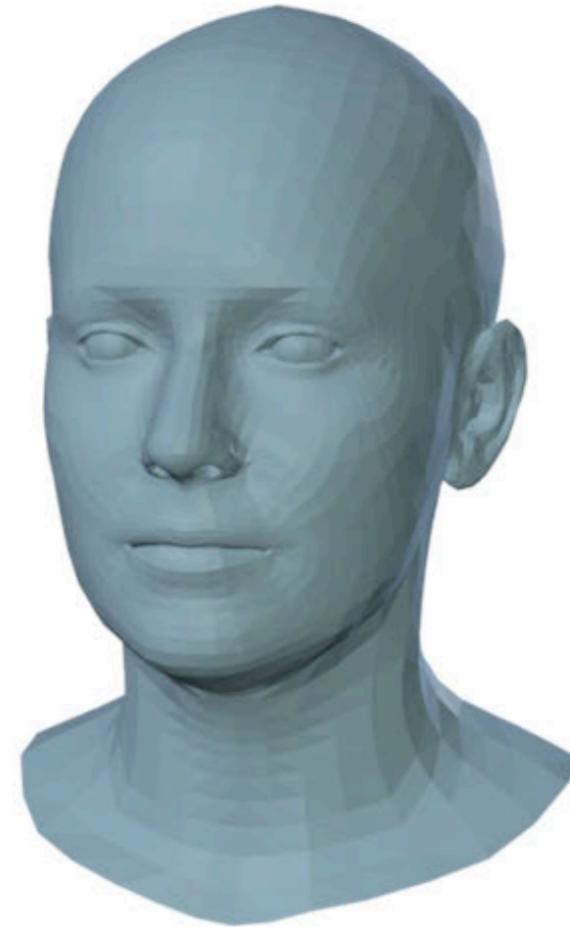
Detail expressions such as eye blinking are also captured

Learned Expression Model

PC #1
between +/- 3 std



male model



female model

Results

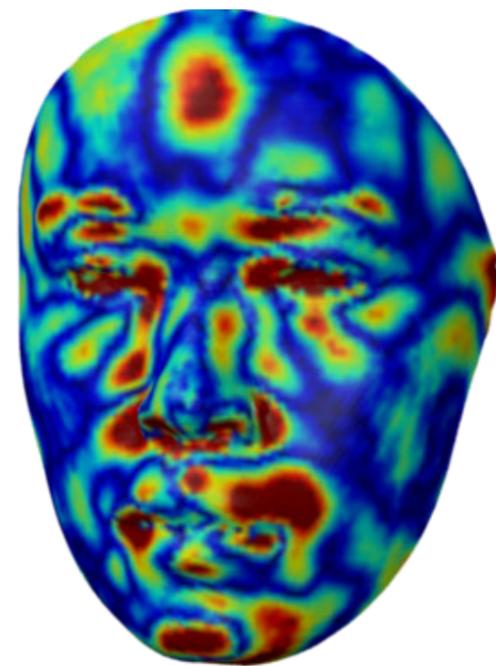
Compare on Identity Space



BU-3DFE scan



Fitting

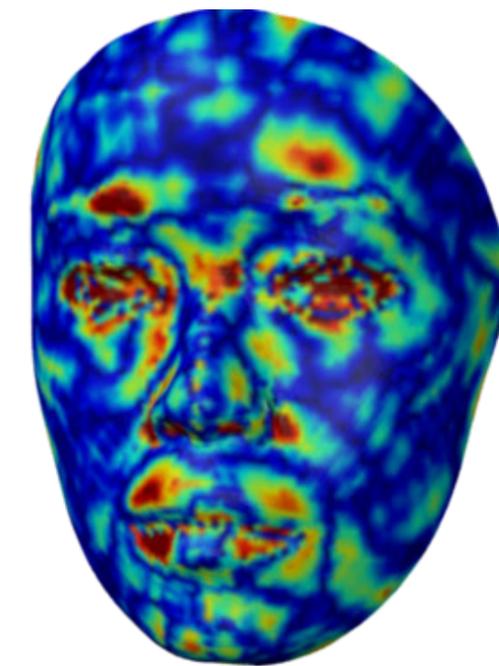


Scan-to-Mesh
Distance

FaceWarehouse
[Cao et al. 2014]
50 components

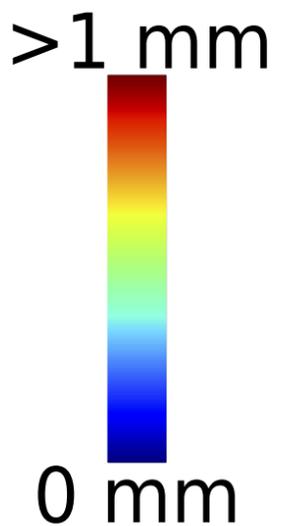


Fitting



Scan-to-Mesh
Distance

FLAME 49
49 components + 1 for gender



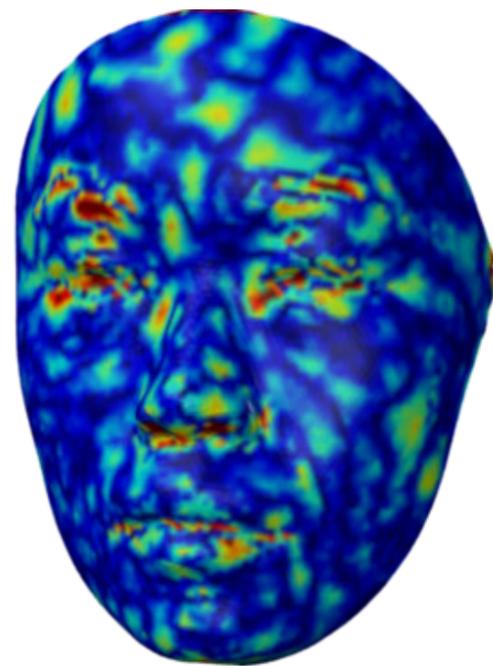
Compare on Identity Space



BU-3DFE scan



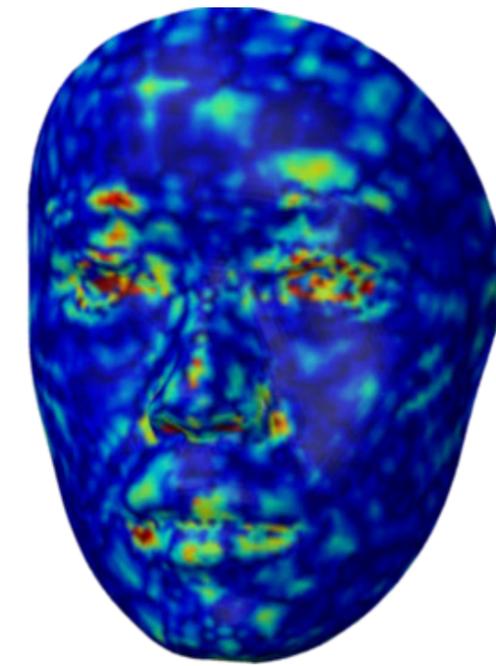
Fitting



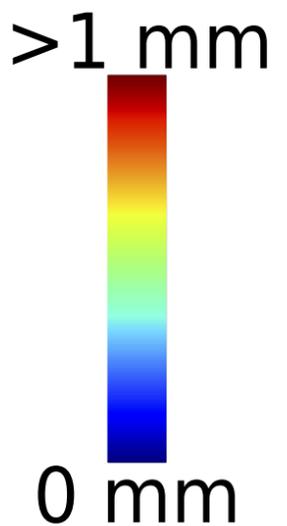
Scan-to-Mesh
Distance



Fitting



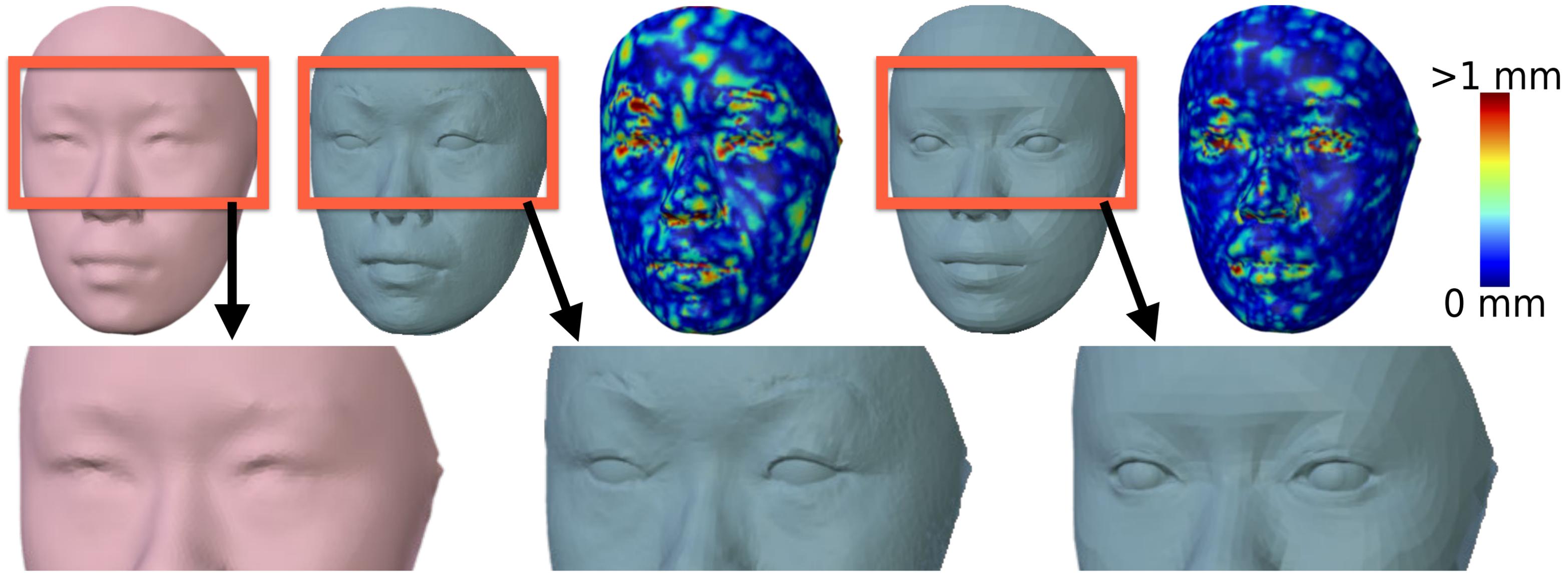
Scan-to-Mesh
Distance



Basel Face Model (BFM)
[Paysan et al. 2009]
199 components

FLAME 198
198 components + 1 for gender

Compare on Identity Space

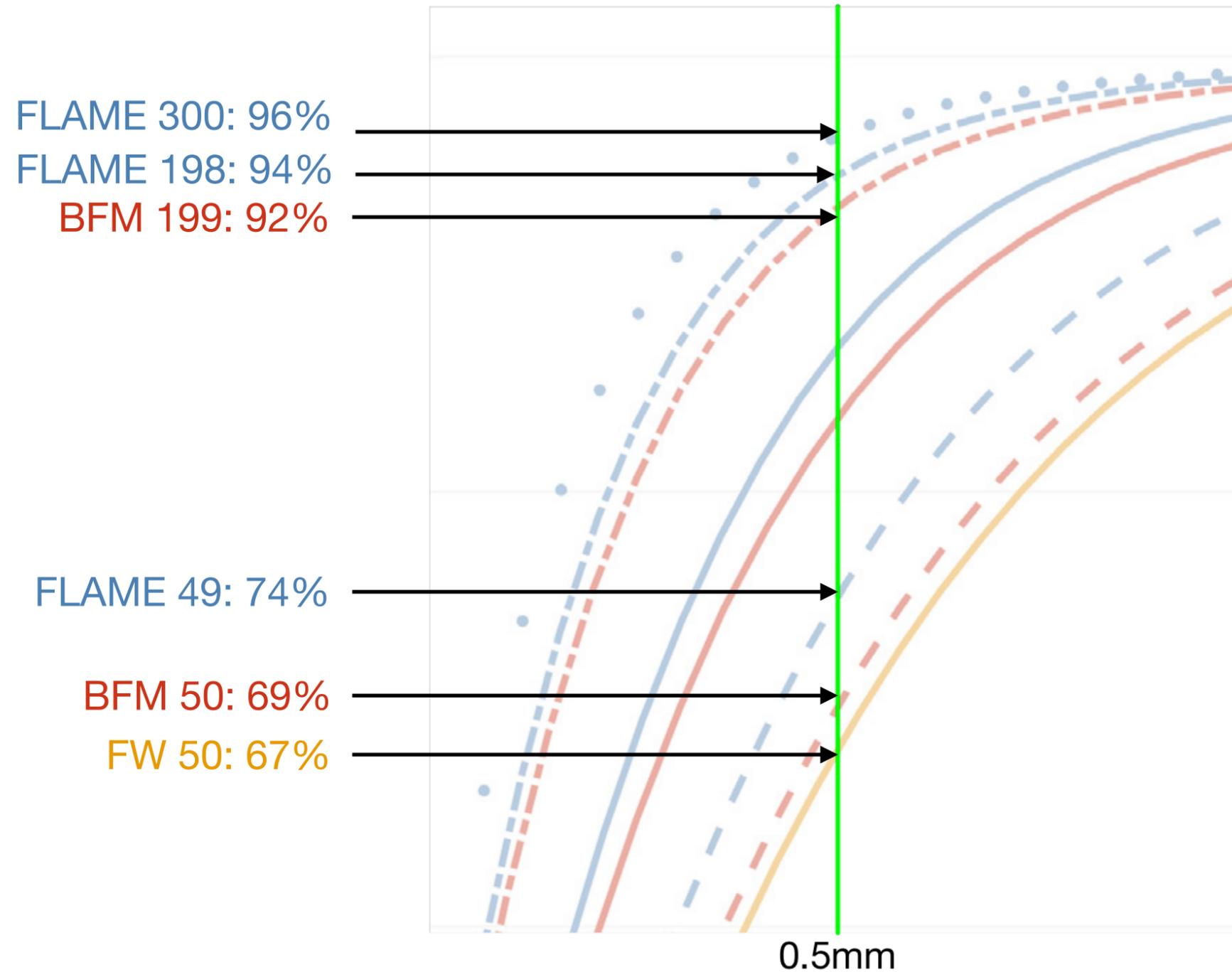


BU-3DFE scan

Basel Face Model (BFM)
199 components

FLAME 198
198 components + 1 for gender

Compare on Identity Space



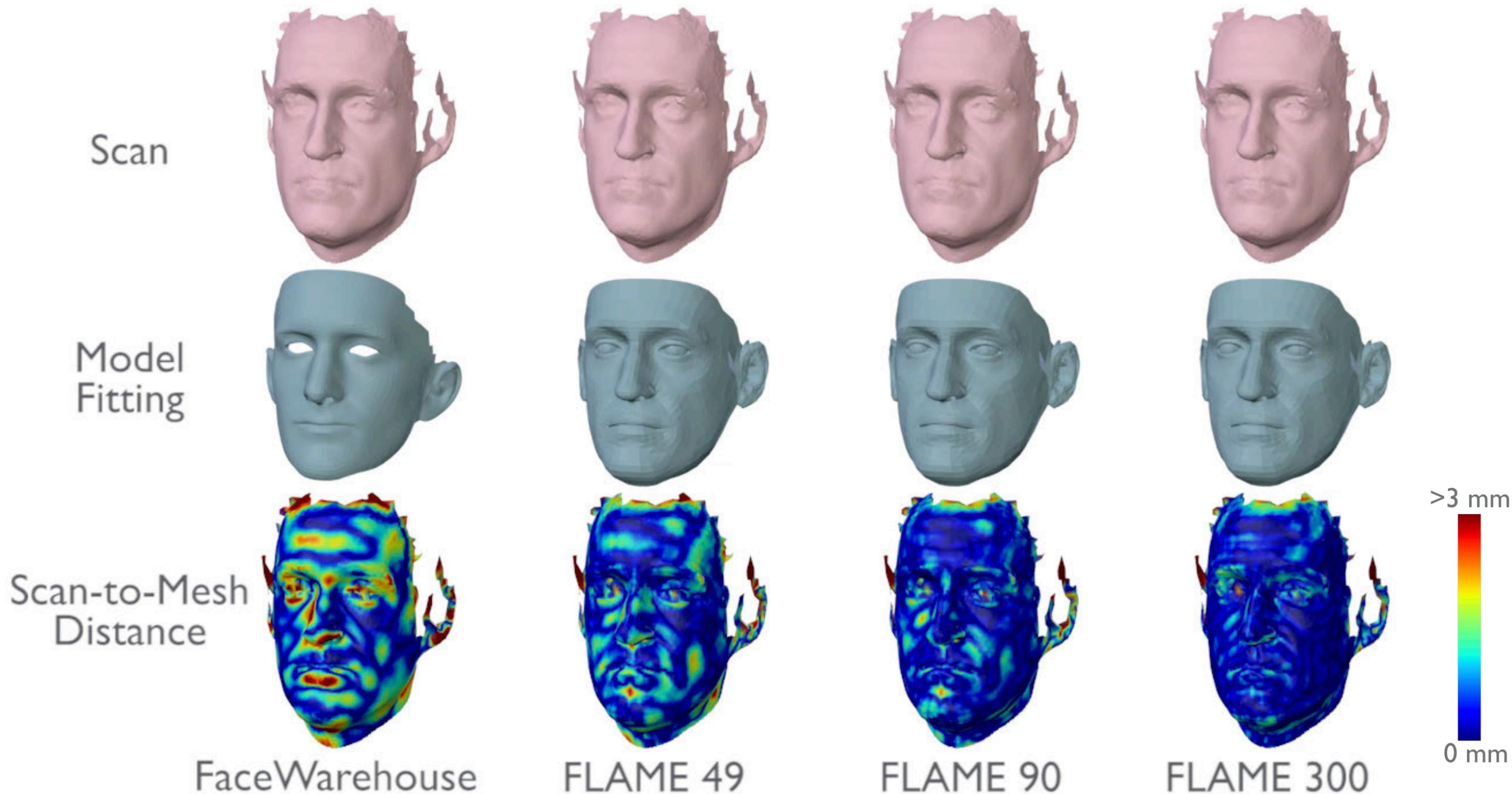
FLAME: our model

BFM: Basel Face Model

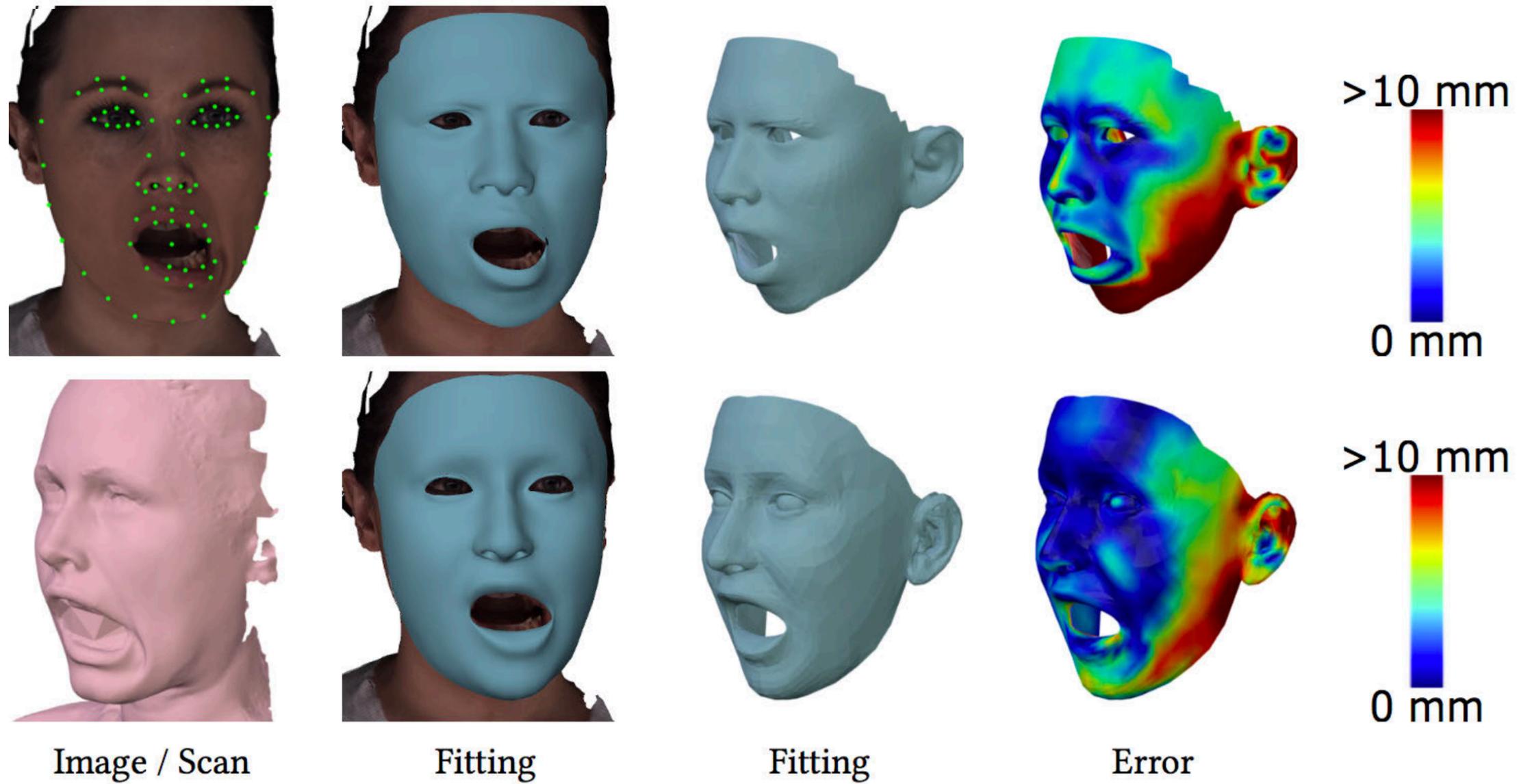
FW FaceWarehouse

Note: higher value is better

Compare on Expression Space

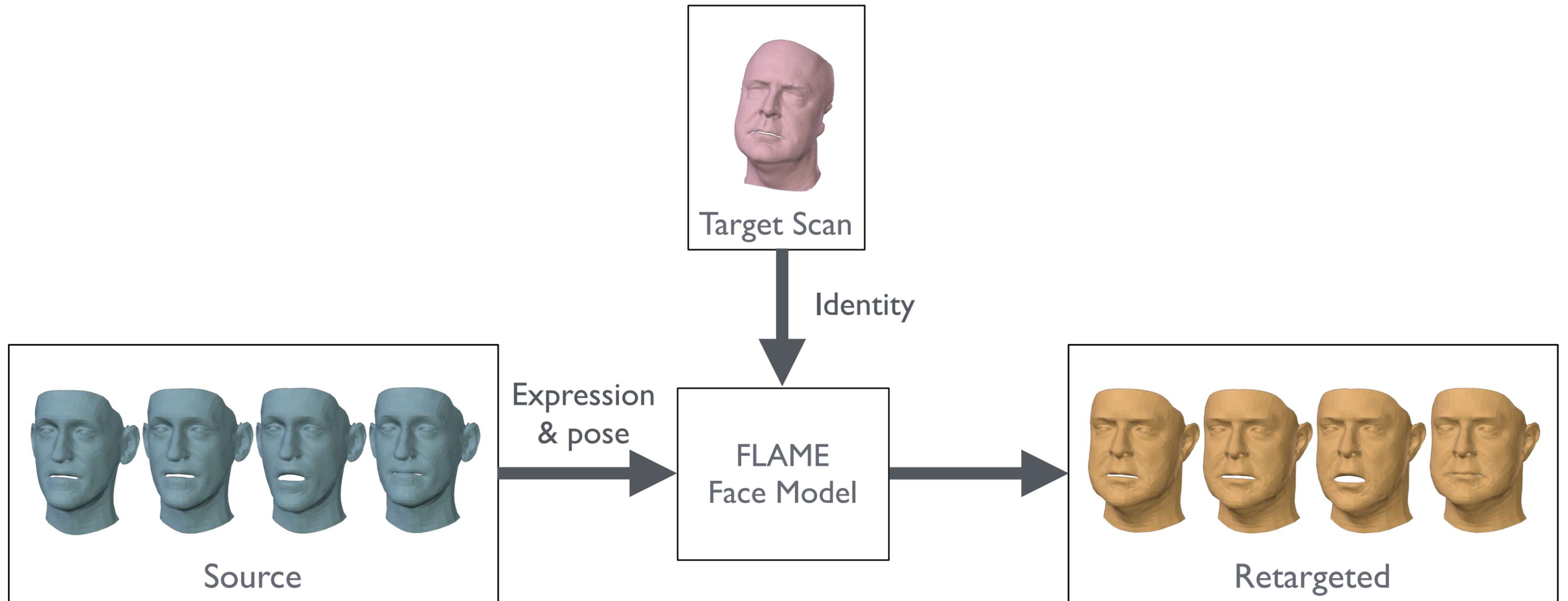


Sparse Landmark Fitting



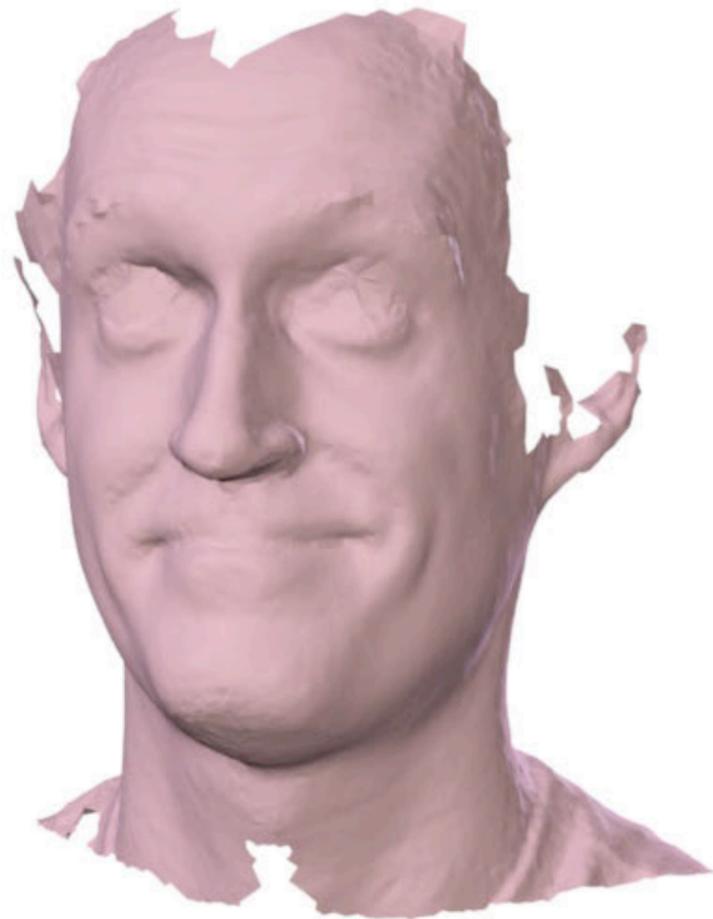
FLAME produces better result in 2D landmark fitting

Application: Retargeting



FLAME retargeting pipeline

Application: Retargeting



Scan



Captured
Performance



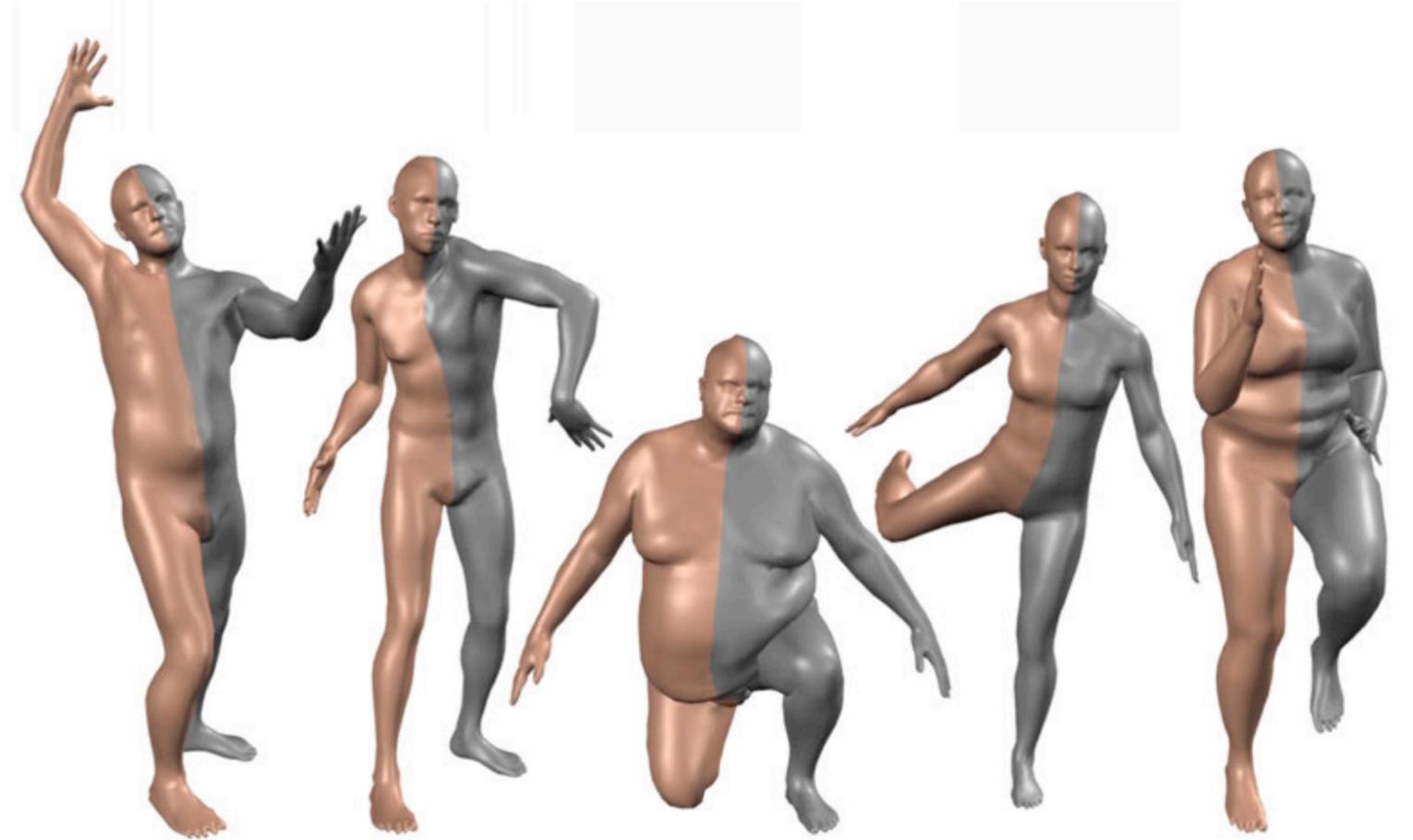
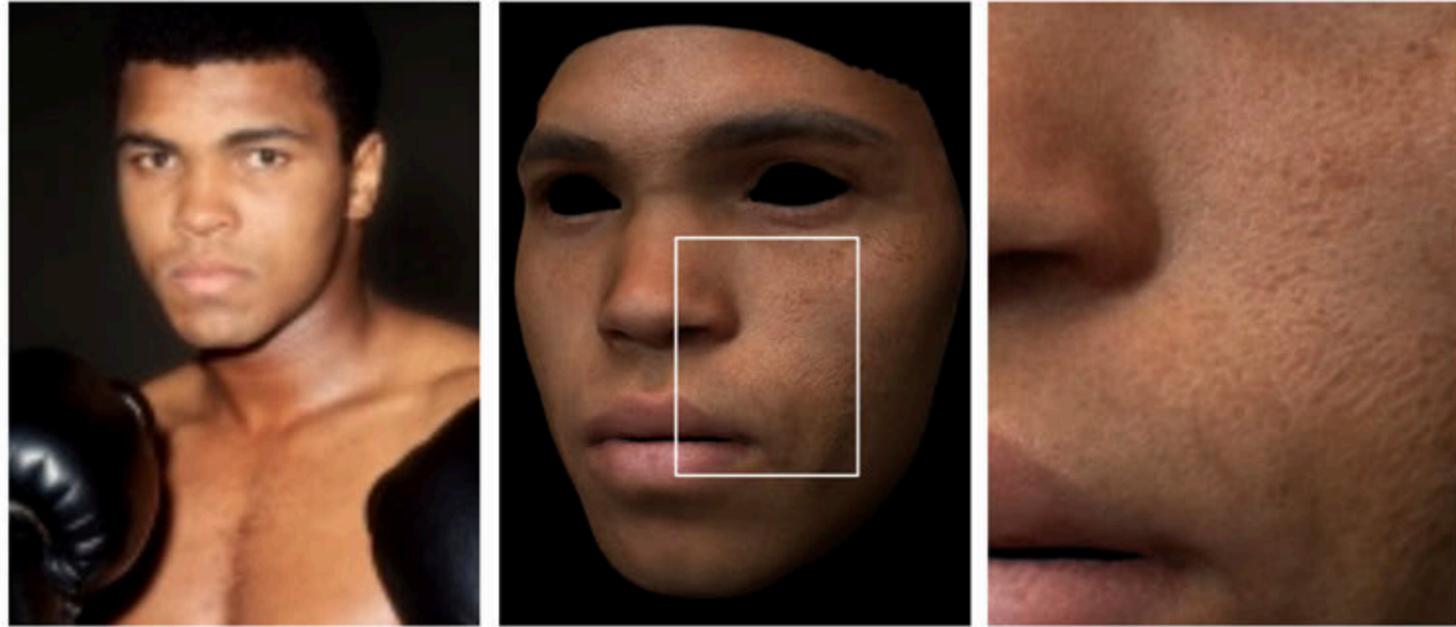
Retargeted

Conclusion

What did we learn

- Large high-quality data
- Separation of identity, pose and expression
- Importance of face prior
- Model and data available for research purpose

Future Work



Acknowledgement

Tsvetelina Alexiadis, Andrea Keller, Jorge Márquez
Data Acquisition

Shunsuke Saito & Cassidy Laidlaw
Evaluation

Yinghao Huang, Ahmed Osman, Naureen Mahmood
Discussion

Talha Zaman
Video Recording

Alejandra Quiros-Ramirez
Project Website

Darren Cosker
Advice and D3DFACS Dataset

Thank You!

<http://flame.is.tue.mpg.de/>

Registrations for D3DFACS dataset

FLAME face model (male / female) with example code