Capturing and Synthesis of Digital Humans

Wojciech Zielonka

Personal Website

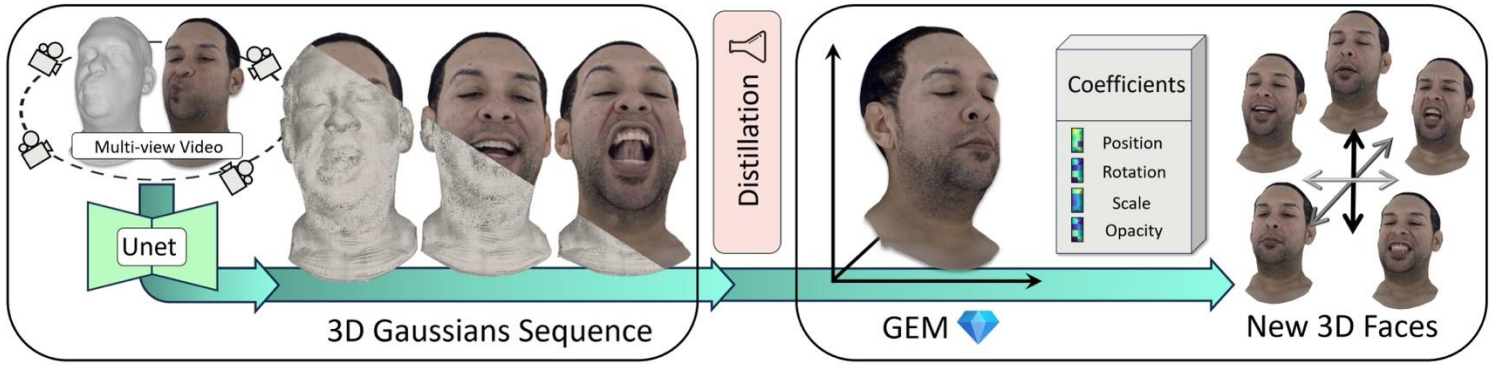
CVPR Nashville JUNE 11-15, 2025

Google

MAX PLANCK INSTITUTE FOR INTELLIGENT SYSTEMS

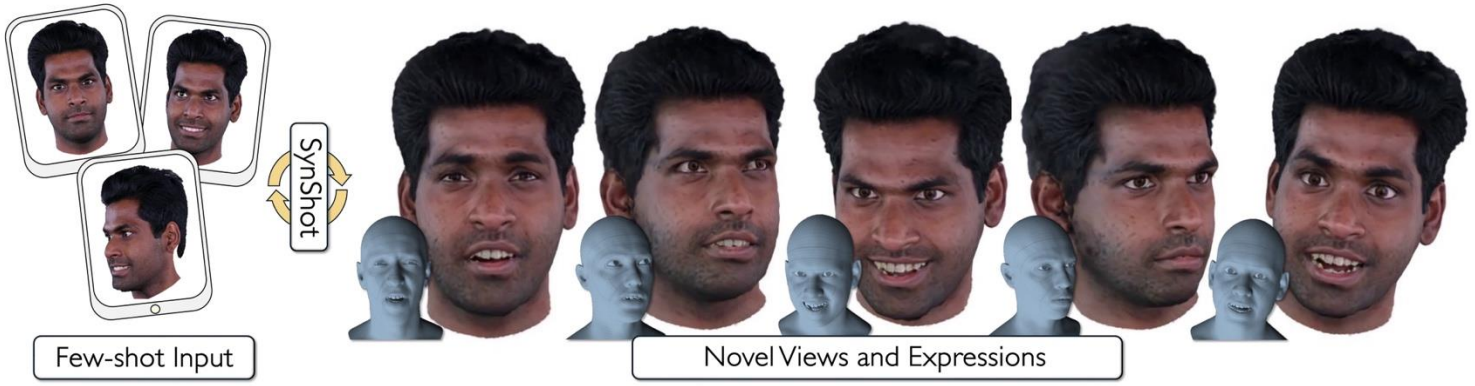
TECHNISCHE UNIVERSITÄT DARMSTADT

Capturing and Synthesis of 3D Digital Humans



GEM - Gaussian Eigen Models for Human Heads

Wojciech Zielonka, Timo Bolkart, Thabo Beeler, Justus Thies



SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

Wojciech Zielonka, Stephan J. Garbin, Alexandros Lattas,
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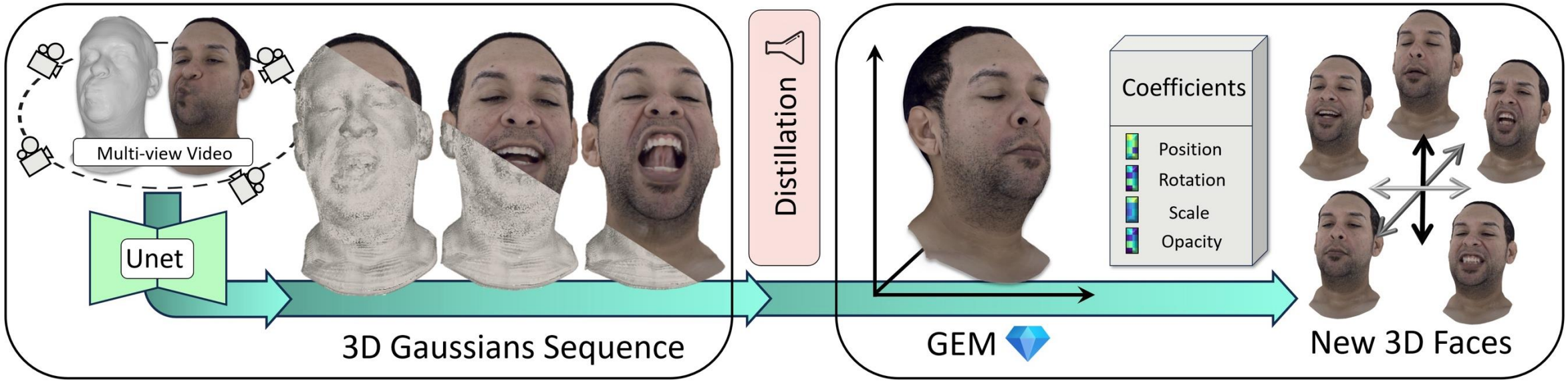

GEM - Gaussian Eigen Models for Human Heads

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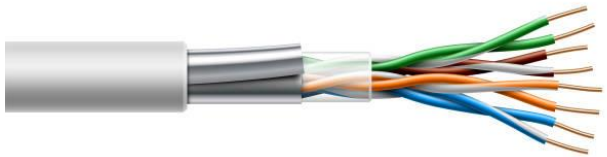
GEM - Motivation

Place A

GEM Avatar

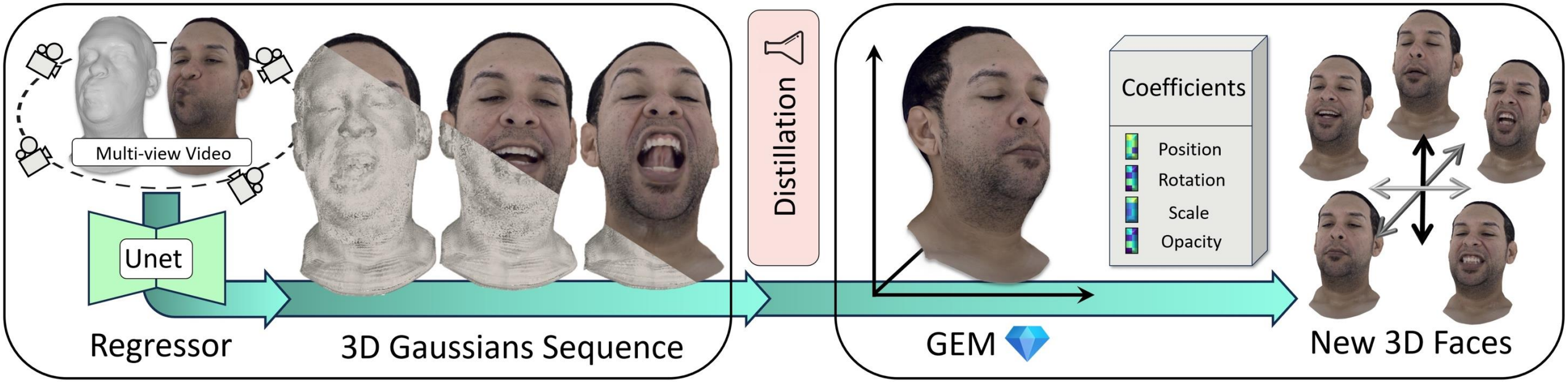


Place B

GEM Avatar

GEM - Gaussian Eigen Models for Human Heads

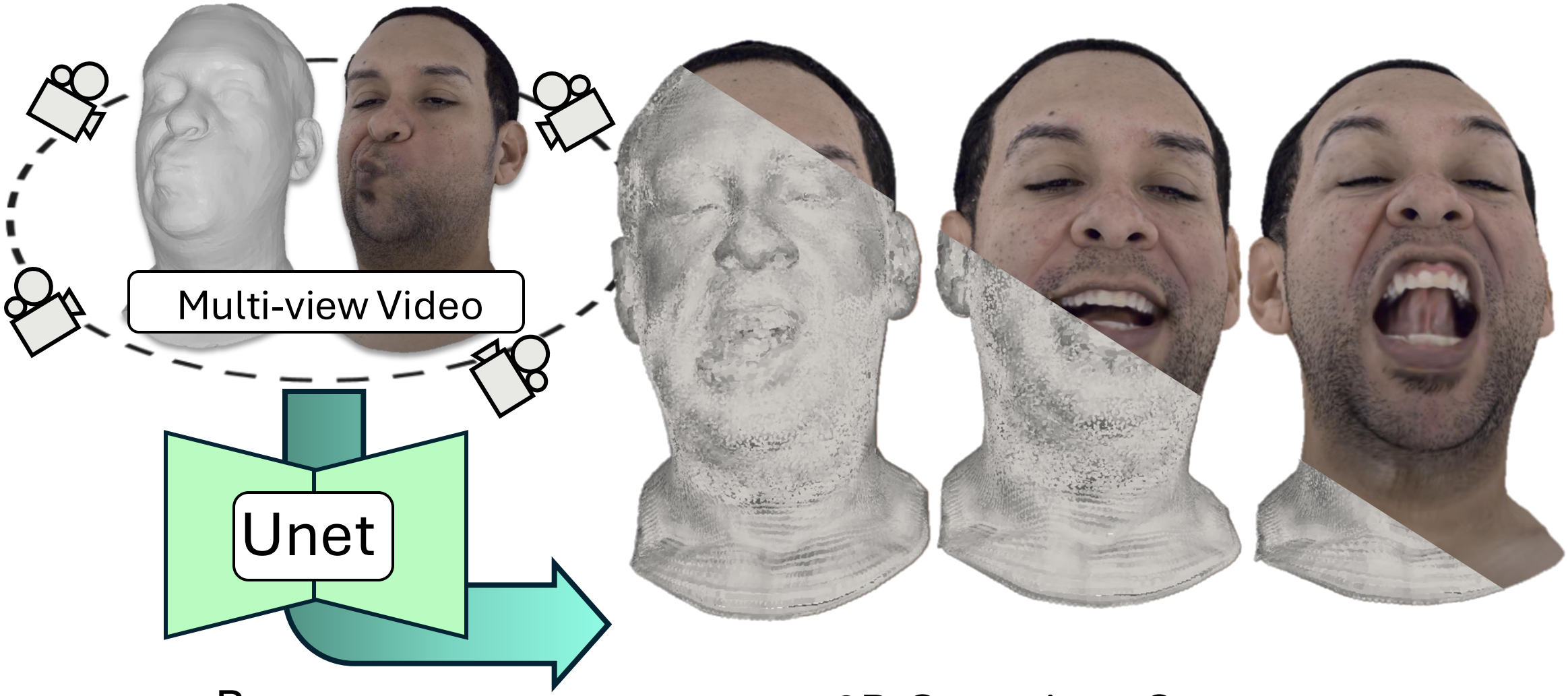
Method



Stage 1

Stage 2

Method (Stage 1)



Method (Stage 2)

Distillation

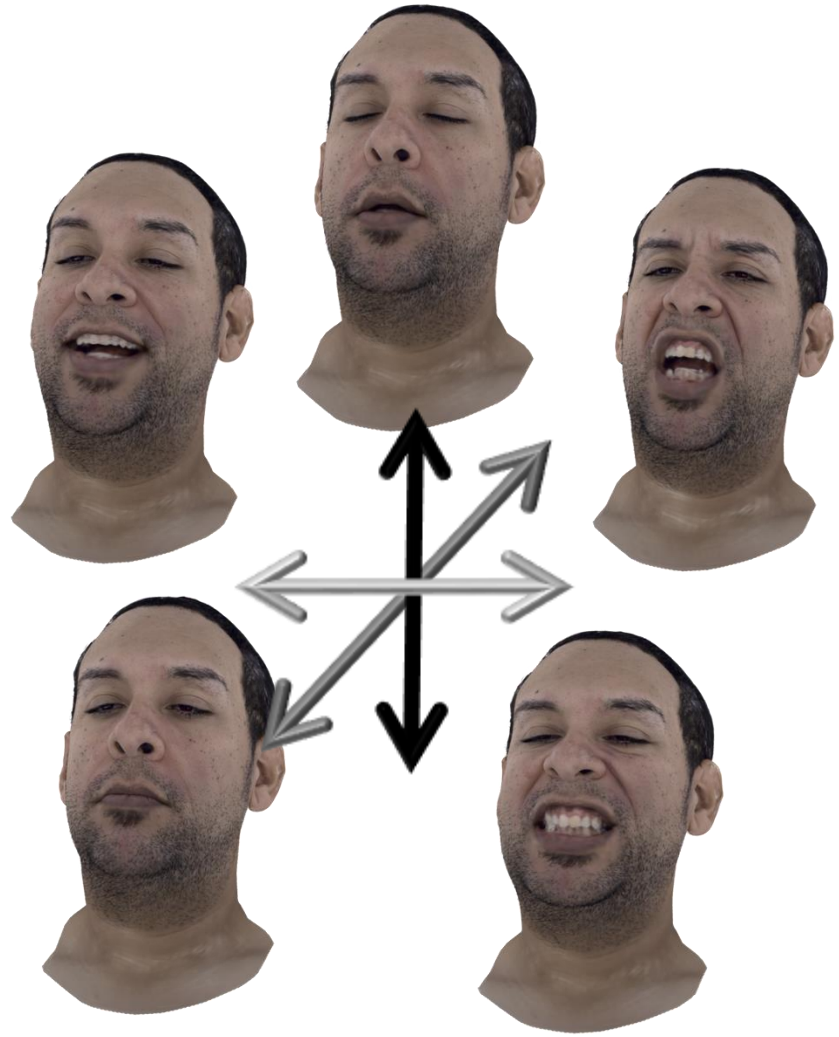
Coefficients

Position

Rotation

Scale

Opacity



GEM

New 3D Faces

Ensamble of eigen basis

Distillation

GEOMETRY COMP 00 = −2.6

OPACITY COMP 00 = −2.6

ROTATION COMP 00 = −2.6

SCALES COMP 01 = −2.6

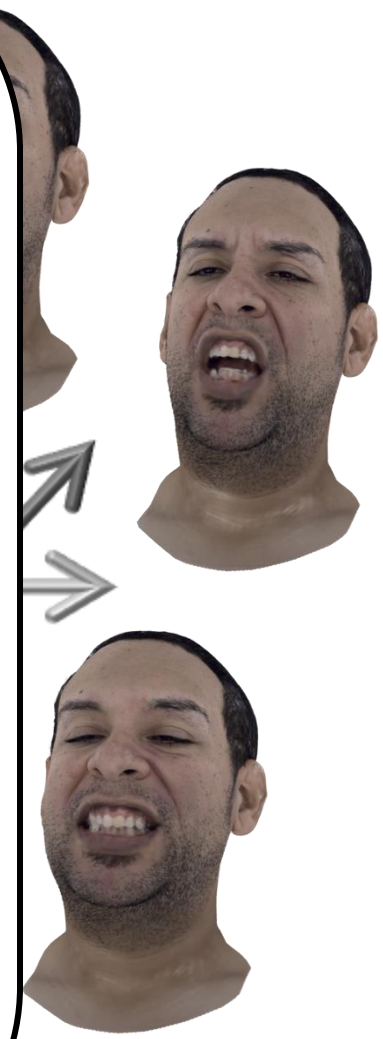
Position

Opacity

Rotation

Scale

Space traversal [-3σ, 3σ]



Faces

GEM - Gaussian Eigen Models for Human Heads

Results – Novel Expressions and Views





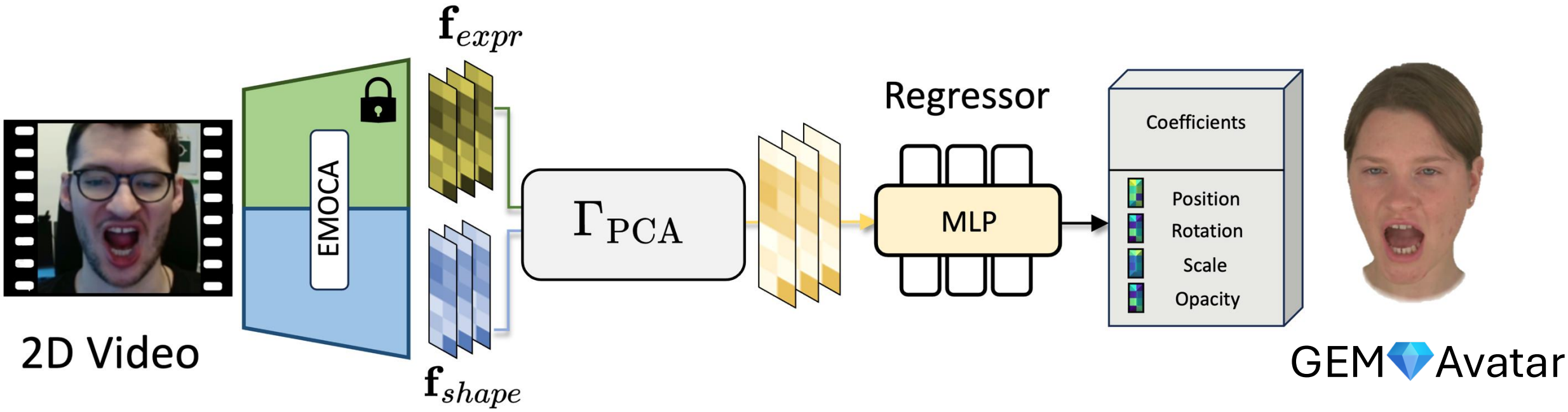

Ground Truth | Ours 💎 GEM | Ours Net 🔥 | AG 🔥 | GA 🔥 | INSTA 🔥

GEM - Gaussian Eigen Models for Human Heads

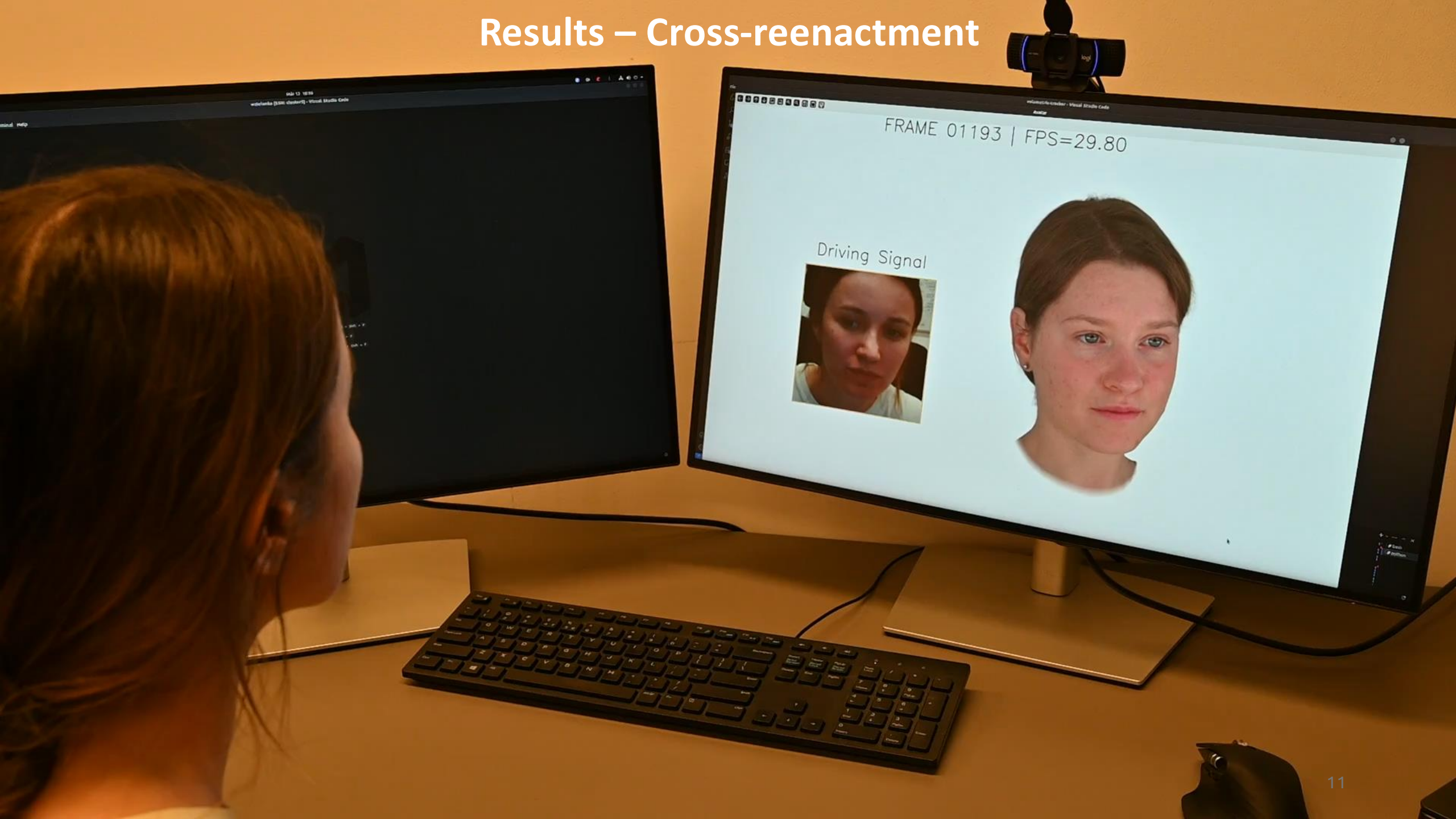
AG – Animatable Gaussians [Li et al.]
GA – Gaussian Avatars [Qian et al.]
INSTA – [Zielonka et al.]

🔥 Needs a 3DMM like FLAME

Image-base Cross-reenactment

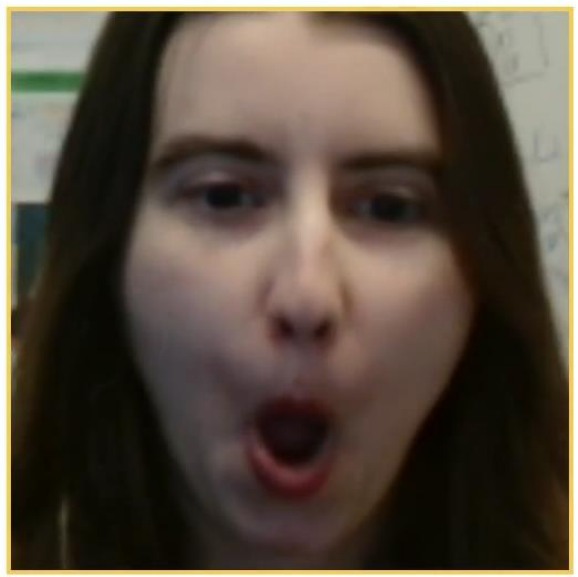


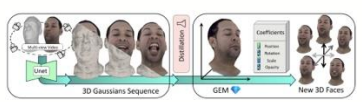
Results – Cross-reenactment



FRAME 03669 | FPS=29.60

Driving Signal





GEM - Gaussian Eigen Models for Human Heads

FRAME 00279 | FPS=30.15

Driving Signal

GEM - Gaussian Eigen Models for Human Heads

Localized PCA

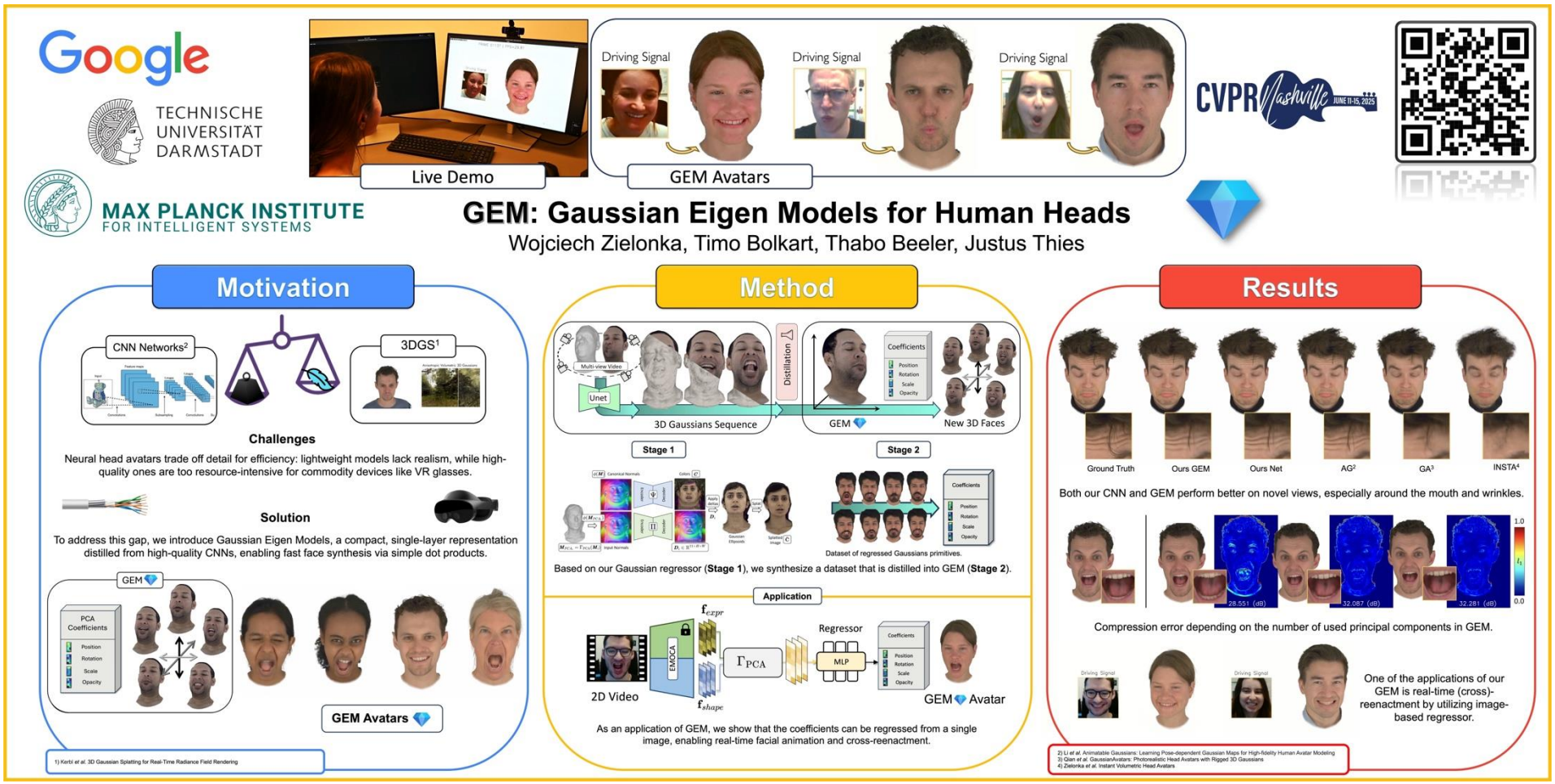
Source

GEM

Localized GEM

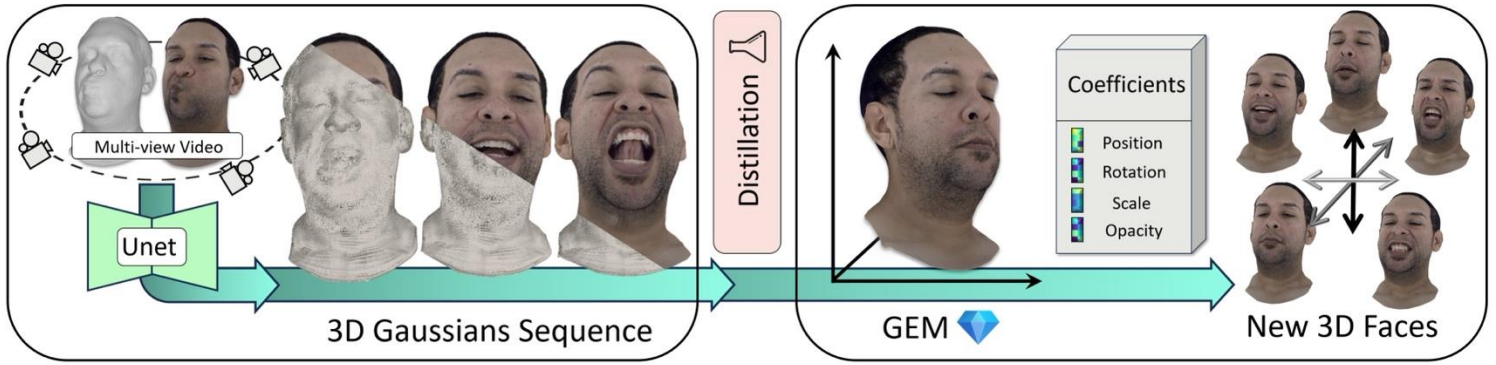
GEM - Gaussian Eigen Models for Human Heads

Summary



Saturday, June 14
17:00 - 19:00 Poster Session 4 & Exhibit Hall (Hall D)
Poster 7

Capturing and Synthesis of 3D Digital Humans



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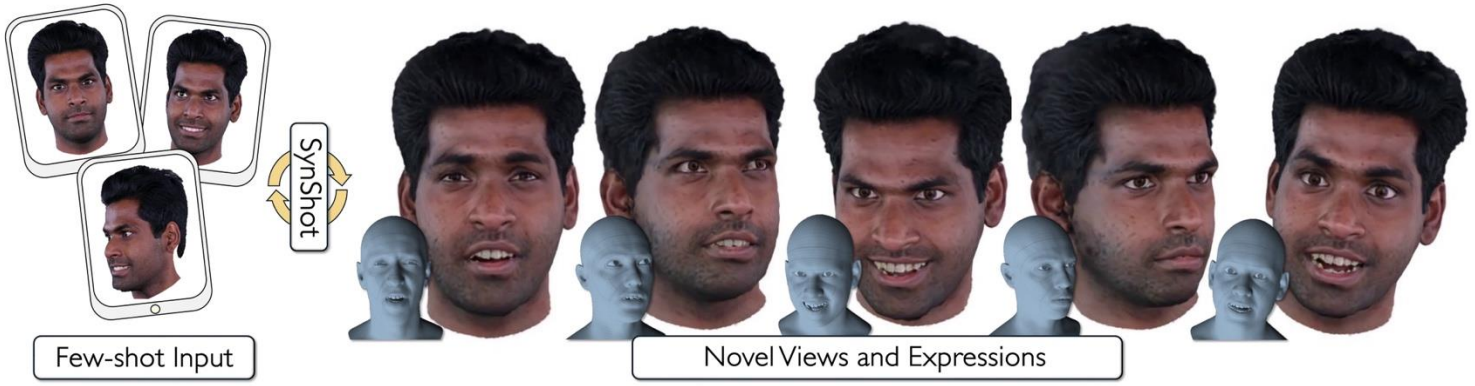

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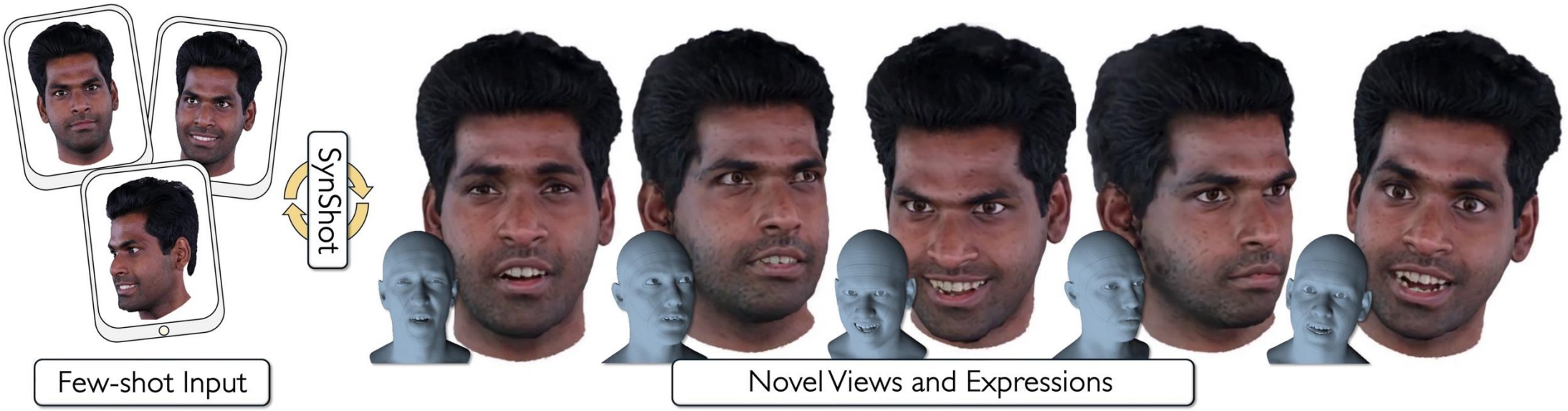

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SynShot – Motivation

Few-shot Input

SynShot

Novel Views and Expressions

SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

Motivation

Source

INSTA[4]

Splatting Avatar[5]

Flash Avatar[6]

SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

4) Zielonka *et al*. Instant Volumetric Head Avatars
5) Xiang *et al*. FlashAvatar: High-fidelity Head Avatar with Efficient Gaussian Embedding
6) Zhijing *et al*. SplattingAvatar: Realistic Real-Time Human Avatars with Mesh-Embedded Gaussian Splatting

Motivation

Source

InvertAvatar[7]

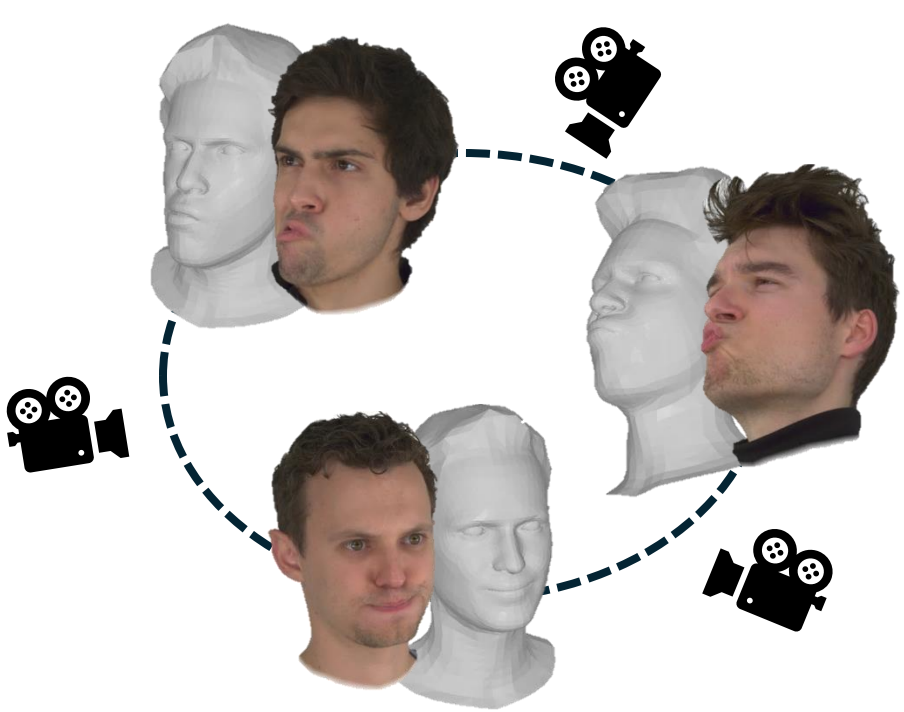
Portrait4D[6]

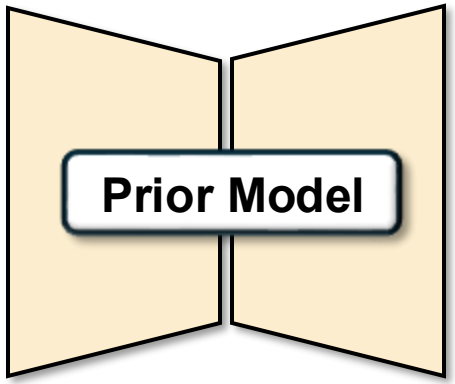
Next3D[8]

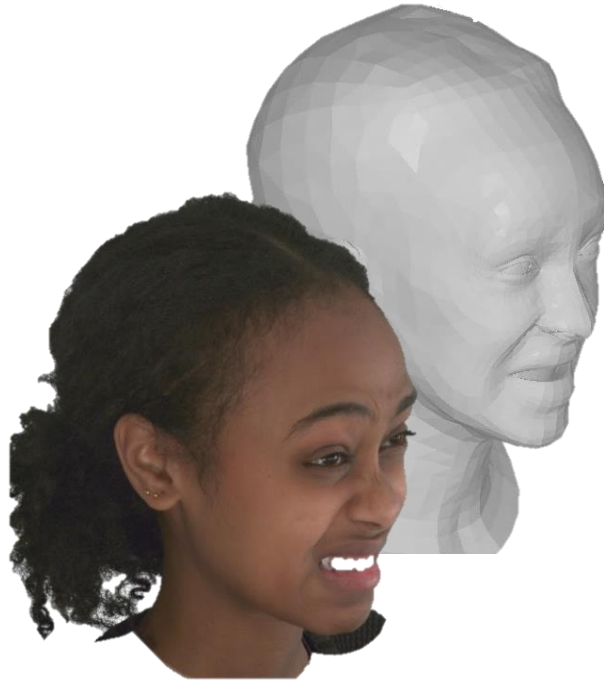
SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

7) Zhao *et al*. InvertAvatar: Incremental GAN Inversion for Generalized Head Avatars
8) Deng *et al*. Portrait4D: Learning One-Shot 4D Head Avatar Synthesis using Synthetic Data
9) Sun *et al*. Next3D: Generative Neural Texture Rasterization for 3D-Aware Head Avatars

Motivation (Solution)







Use multi-view dataset with tracked meshes to build a prior model used for inversion and driving the avatars

Motivation

Nersemble[1]

Multiface[2]

FaceScape[3]

SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

1) Kirschstein *et al.* NeRSemble: Multi-View Radiance Field Reconstruction of Human Heads
2) Wuu *et al.* Multiface: A Dataset for Neural Face Rendering
3) Zhu *et al.* FaceScape: 3D Facial Dataset and Benchmark for Single-View 3D Face Reconstruction

Motivation

The **General Data Protection Regulation (GDPR)** is an EU law that protects individuals' personal data and privacy, enforced since May 25, 2018.

What does it mean for **Digital Humans research**:

1. Dataset derivatives must be frequently deleted e.g., each 30 days.
2. Trained models the same, periodically removed.

Nersemble[1] **Multiface**[2] **FaceScape**[3]

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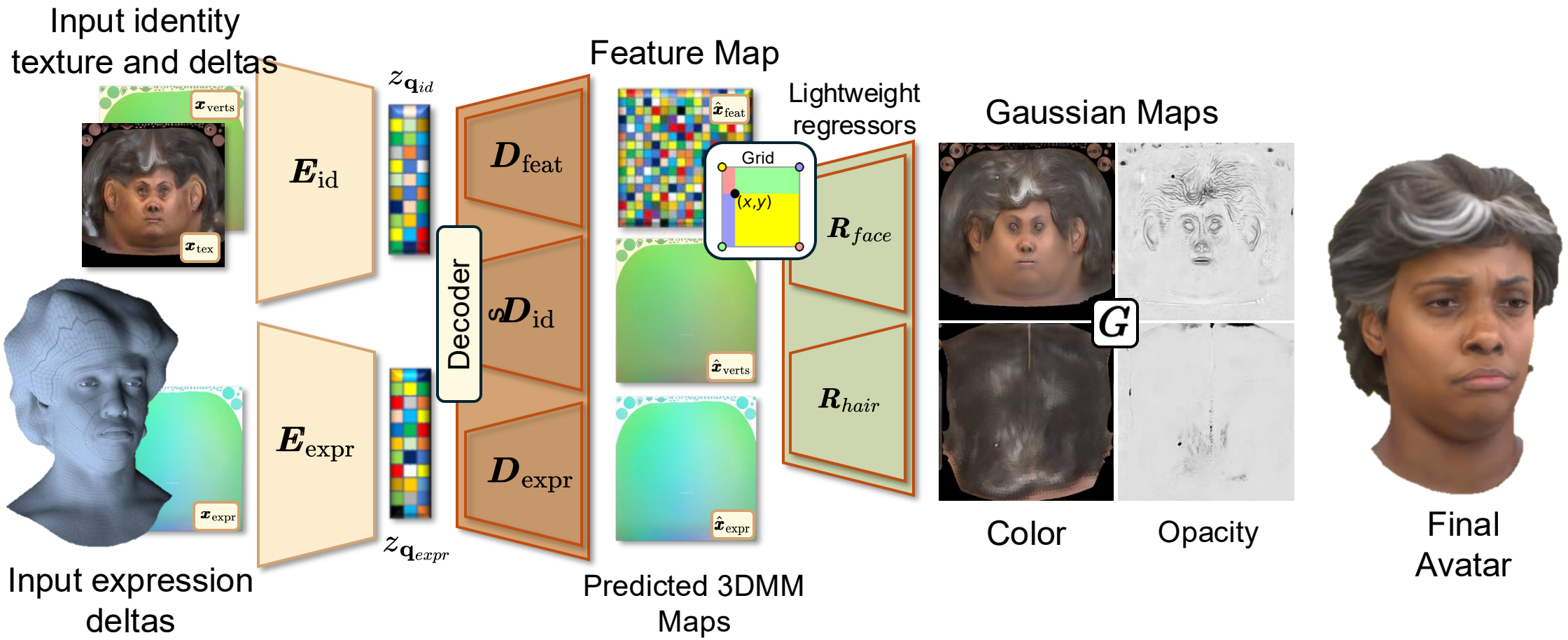
Motivation – Synthetics

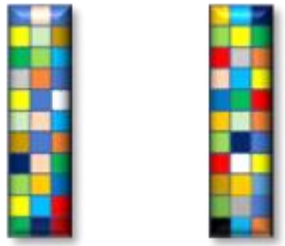
SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

Method


Input identity texture and deltas
x_{verts}
x_{tex}
E_{id}
$z_{\mathbf{q}_{id}}$
x_{expr}
E_{expr}
$z_{\mathbf{q}_{expr}}$
Input expression deltas
Decoder
D_{feat}
sD_{id}
D_{expr}
Feature Map
$\hat{x}_{\text{feat}}$
$\hat{x}_{\text{verts}}$
$\hat{x}_{\text{expr}}$
Predicted 3DMM Maps
Grid
(x,y)
Lightweight regressors
R_{face}
R_{hair}
Gaussian Maps
G
Color
Opacity
Final Avatar

Method – Latent Space Interpolation

$z_{\mathbf{q}_{id}}$ $z_{\mathbf{q}_{expr}}$



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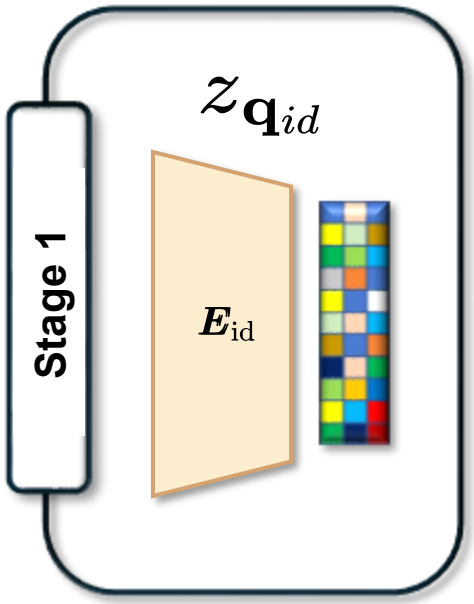
Method – Inversion

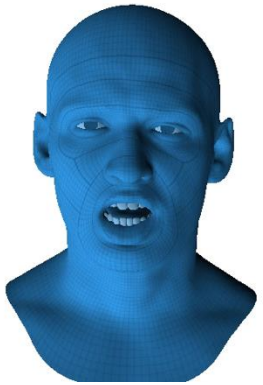
Few-shot Input

Inverted Avatar

Inversion – Stage 1

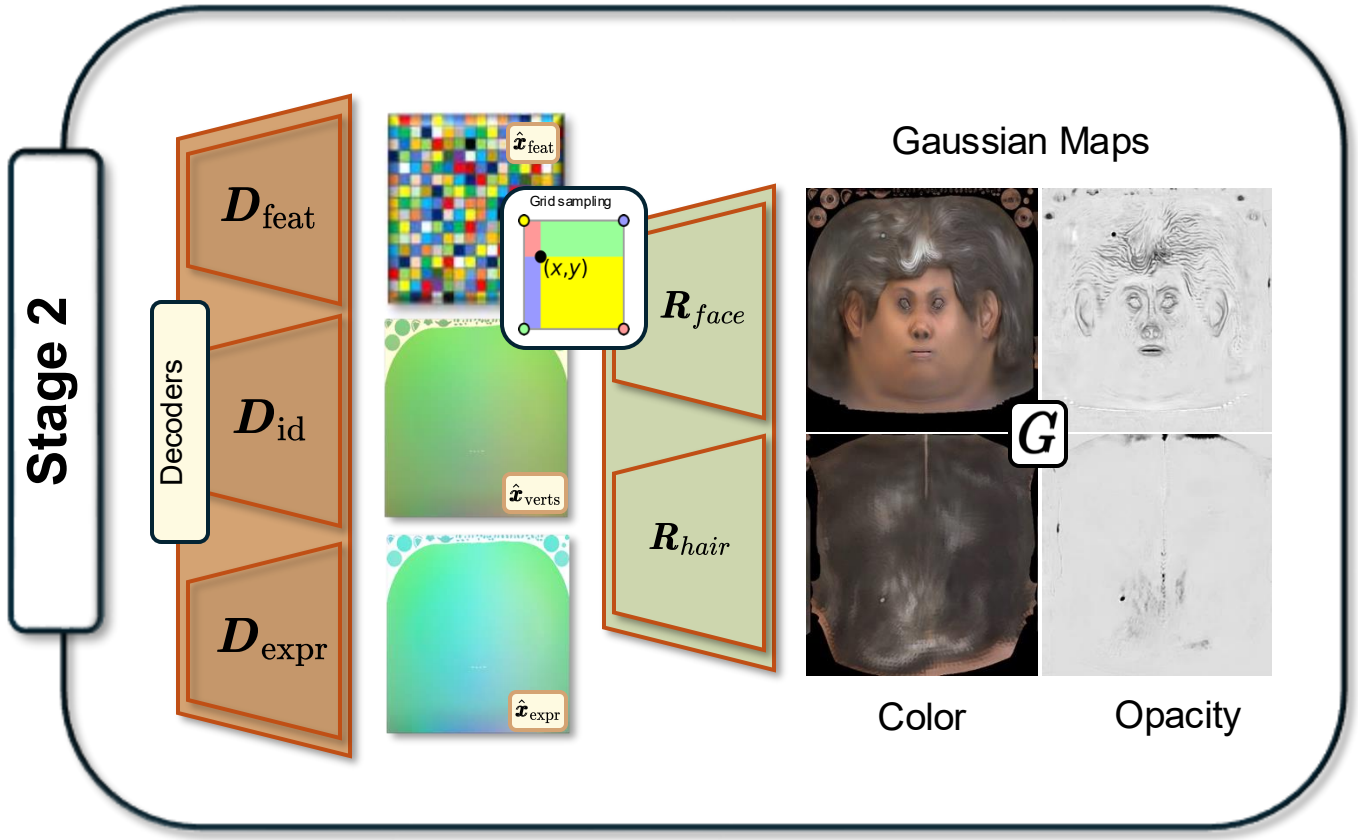
Input

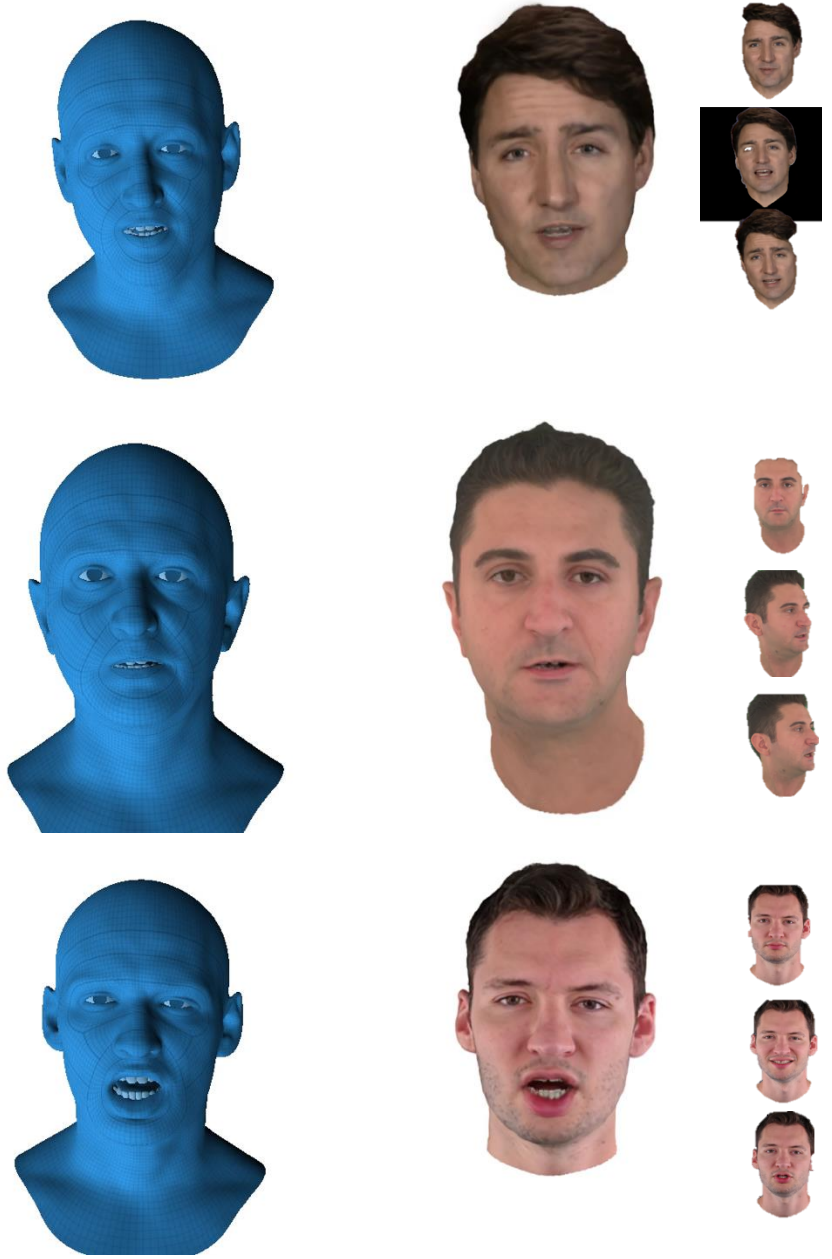




SynShot - Synthetic Prior for Few-Shot Drivable Head Avatar Inversion

Inversion – Stage 2





Results – Personalized-baselines

Source

Ours

INSTA[4]

Splatting Avatar[5]

Flash Avatar[6]

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Source **Ours** **InvertAvatar**[7] **Portrait4D**[6] **Next3D**[8]

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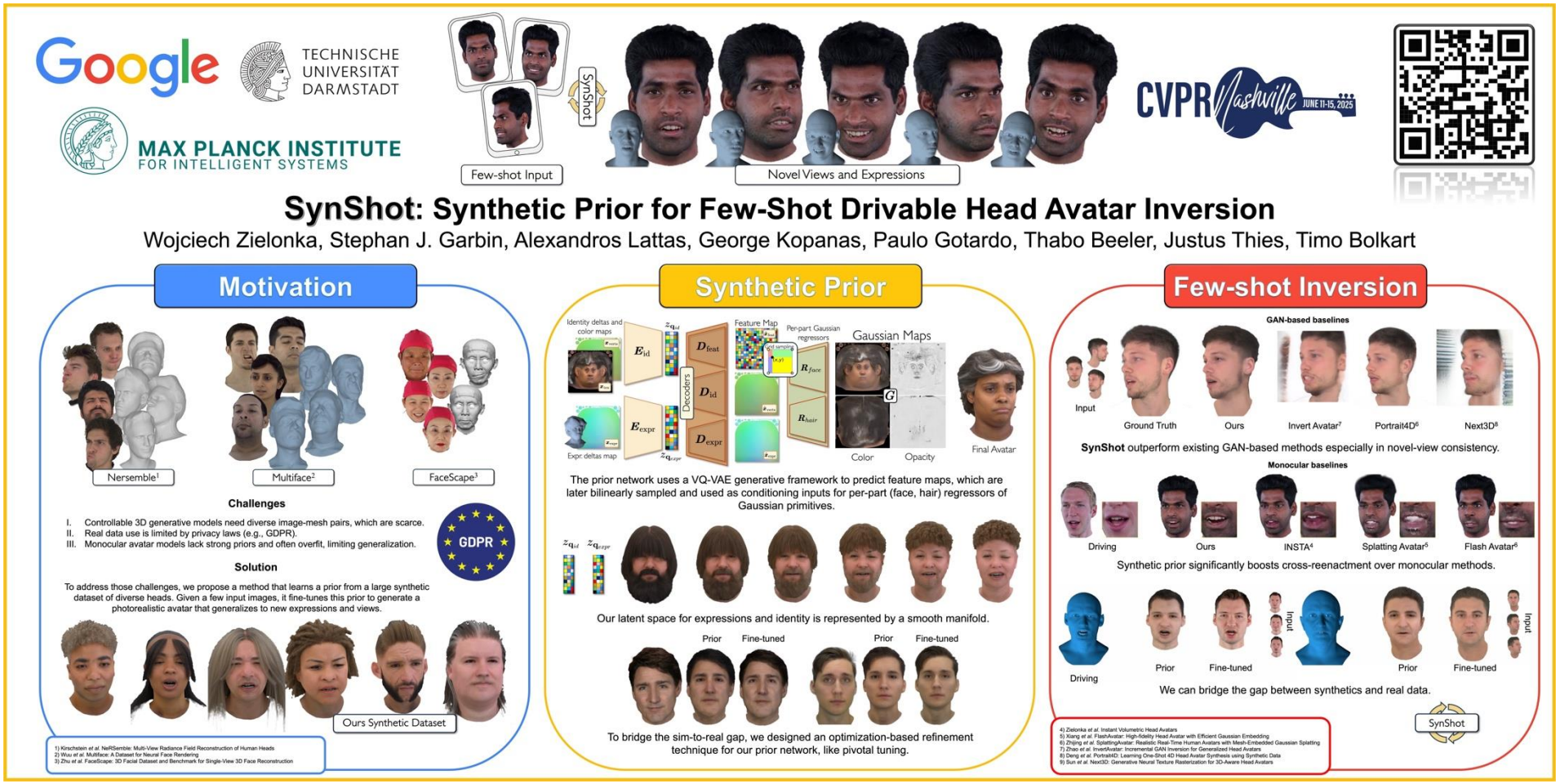
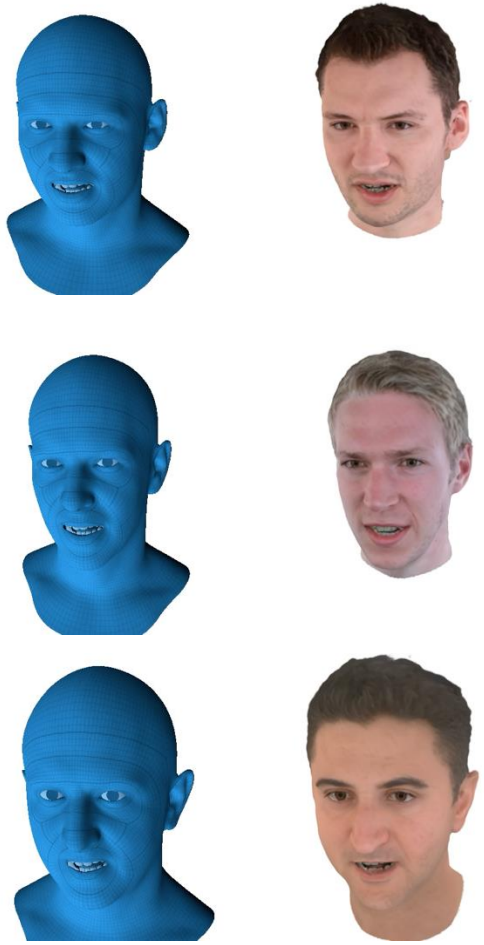
Results

Summary





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Poster 8

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