HairCUP

Hair Compositional Universal Prior for 3D Gaussian Avatars

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Jason Saragih[2] Hanbyul Joo[1] Junxuan Li[2]

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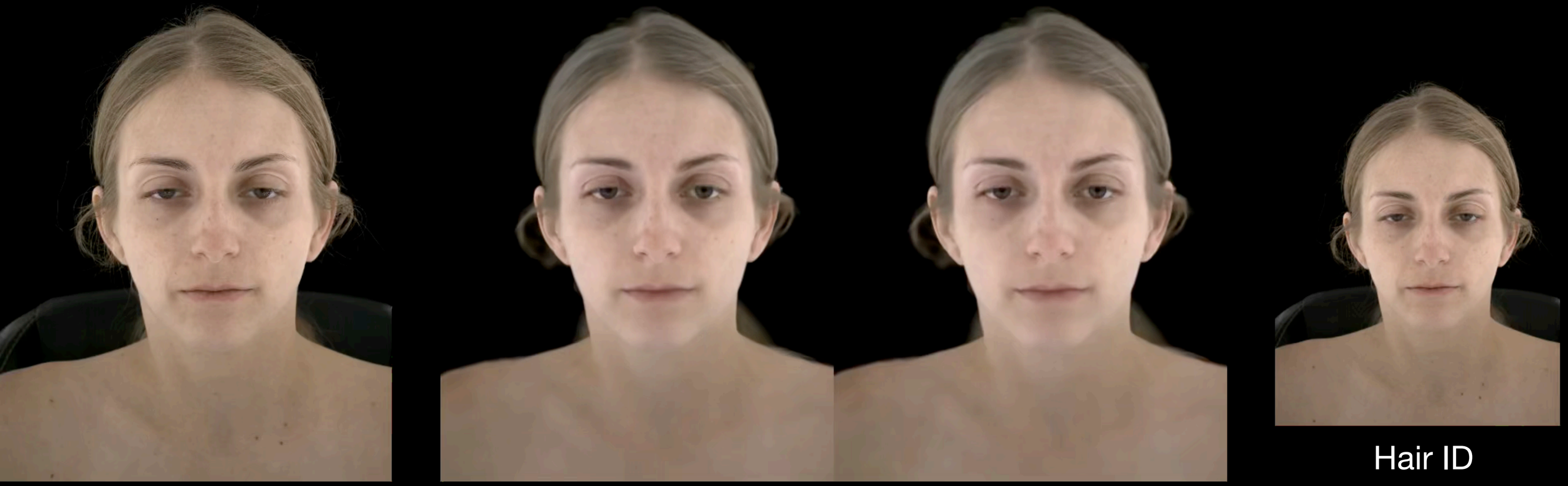
https://www.hermosahair.com/blogs/blog/billie-eilish-hairstyles

“Compositional” Universal Codec Avatars

Disentangled Face/Hair Representation



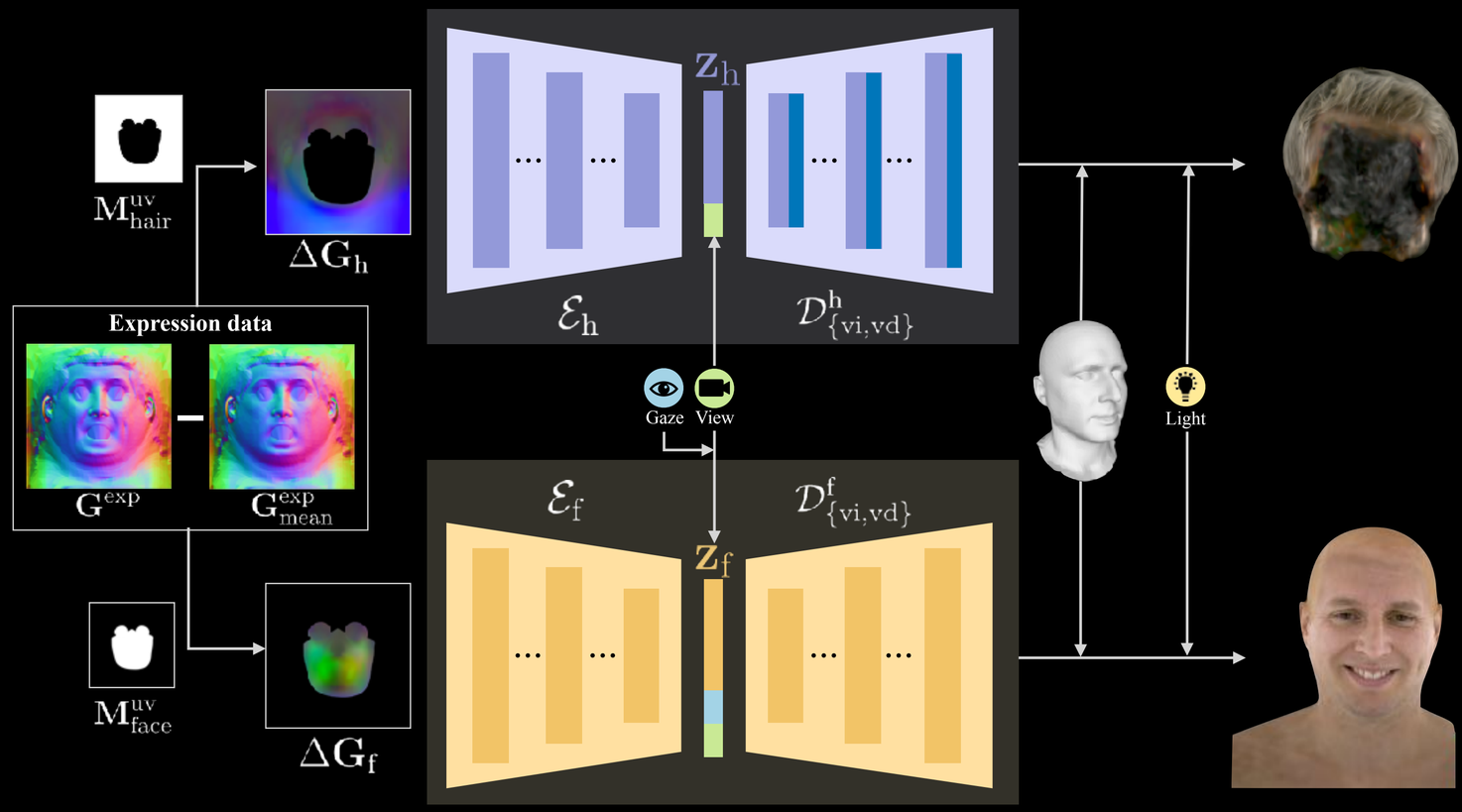
Target Expression

Compositional Universal Relightable Avatar

Hair ID

Overview

Paired Dataset Construction



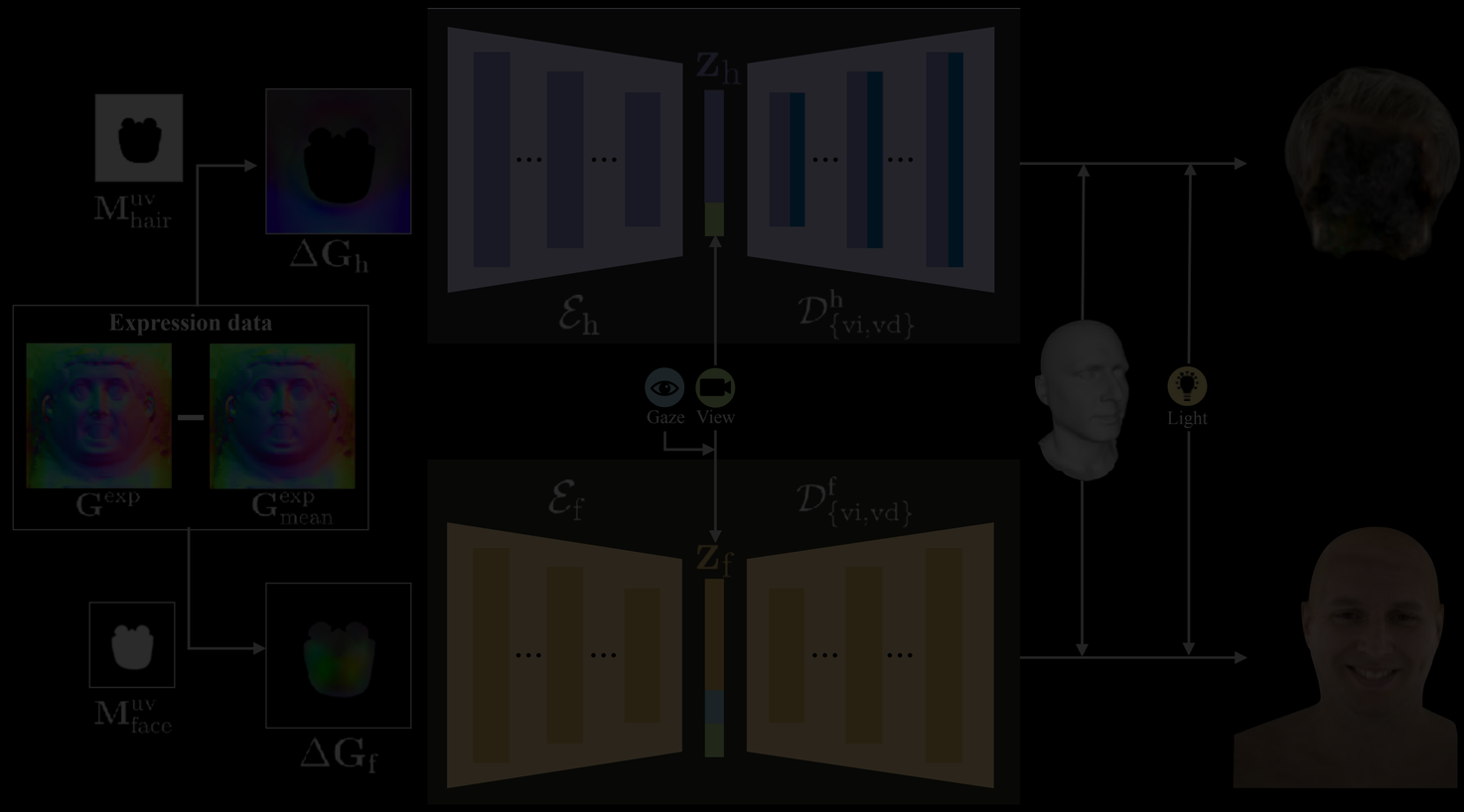
Compositional Avatar Model

Overview

Paired Dataset Construction

Multi-view Captures

Synthetic Bald Images



Paired Dataset Construction

Compositional Avatar Model

Overview

Paired Dataset Construction

Multi-view Captures

Synthetic Bald Images

Paired Dataset Construction

https://www.tiktok.com/@branca.biasiori/video/7544184523362225422

Overview

Paired Dataset Construction

Multi-view Captures

Synthetic Bald Images

Synthetic Bald Image Generation

Dataset for Codec Avatars

Multi-view Captures

Tracking mesh

Texture map

Synthetic Bald Image Generation

Bald Tracking Mesh

Multi-view Captures

Tracking mesh

Texture map

Bald tracking mesh

Synthetic Bald Image Generation

Bald Tracking Mesh

Multi-view Captures

Tracking mesh

Texture map

Bald tracking mesh

Bald texture map

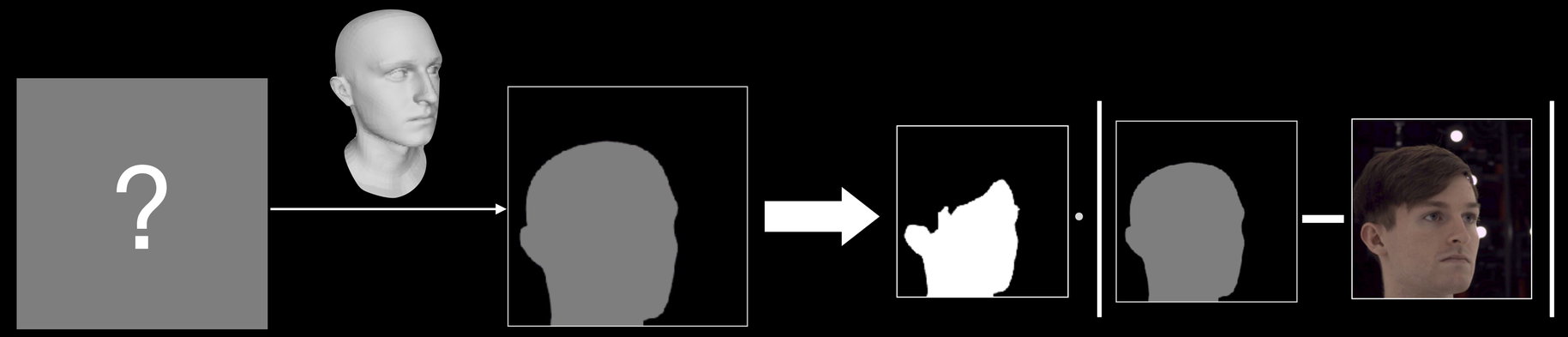
Synthetic Bald Image Generation

Bald Texture Optimization

Bald texture map

Synthetic Bald Image Generation

Bald Texture Optimization



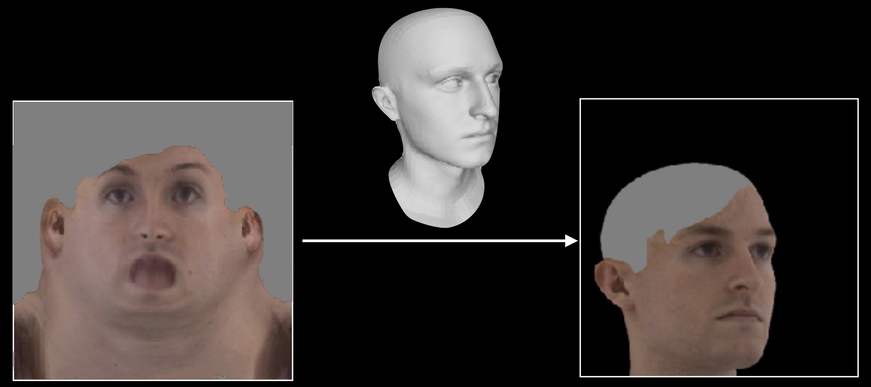
Bald texture map

Rendered bald mesh

Face Reconstruction Loss

Synthetic Bald Image Generation

Bald Texture Optimization

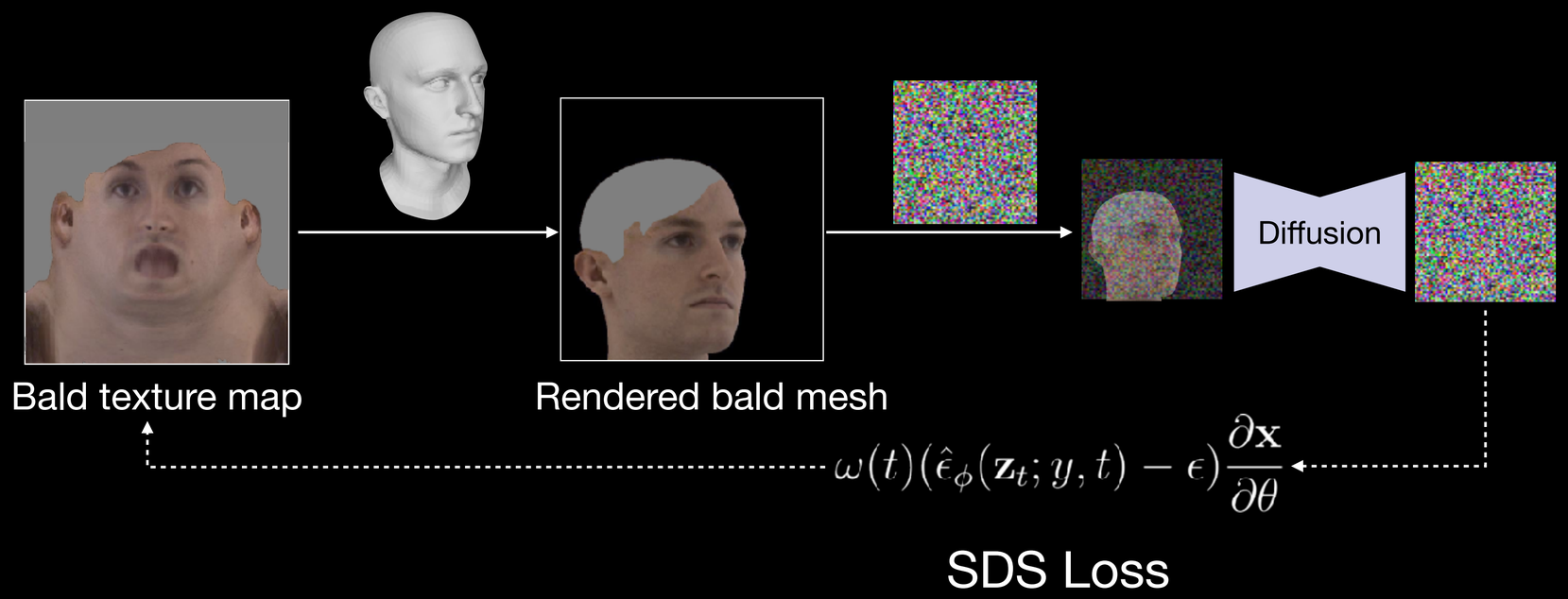


Bald texture map

Rendered bald mesh

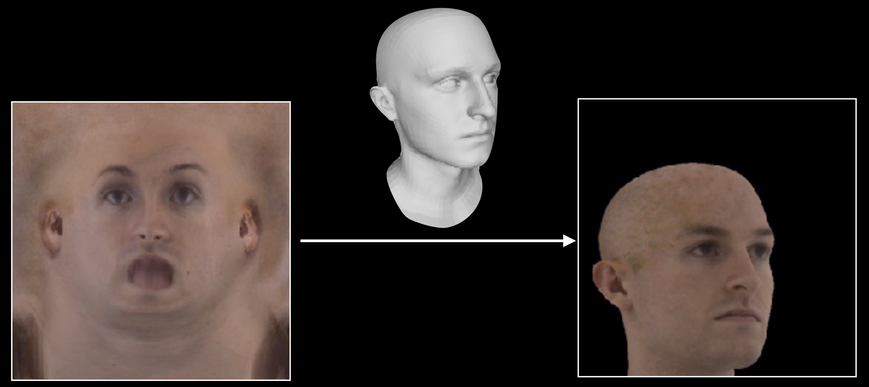
Synthetic Bald Image Generation

Bald Texture Optimization



Synthetic Bald Image Generation

Bald Texture Optimization



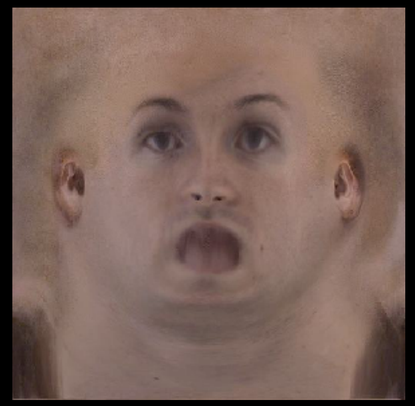
Bald texture map

Rendered bald mesh

Synthetic Bald Image Generation

Bald Texture Optimization

Bald Tracked Mesh



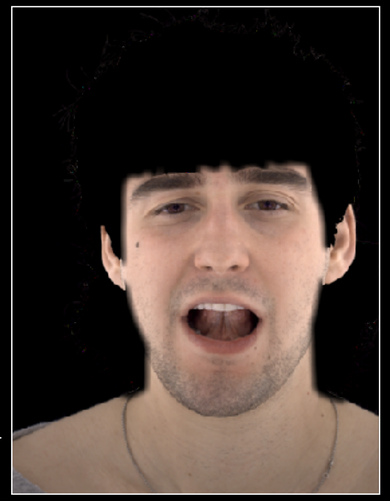
Bald Texture Map

Synthetic Bald Image Generation

Synthetic Bald Image Generation

Original capture

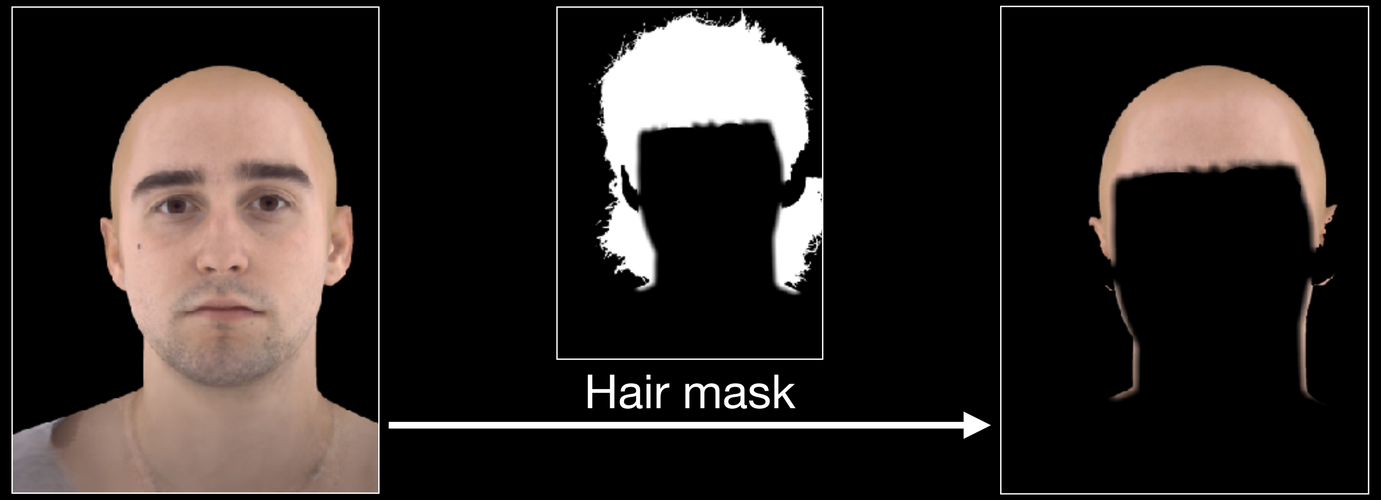
Face mask



Synthetic Bald Image Generation

Synthetic Bald Image Generation

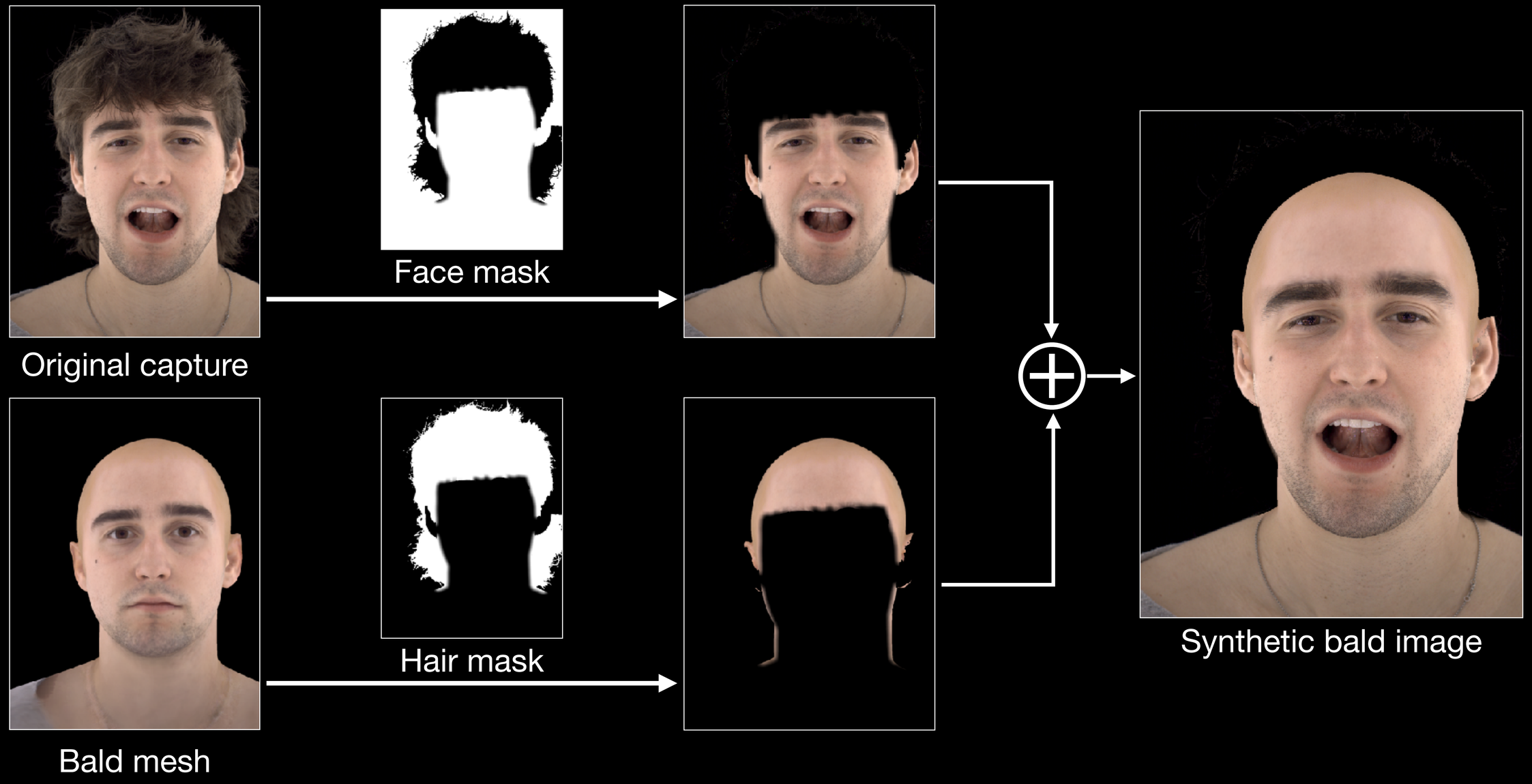
Original capture



Neutral Bald mesh

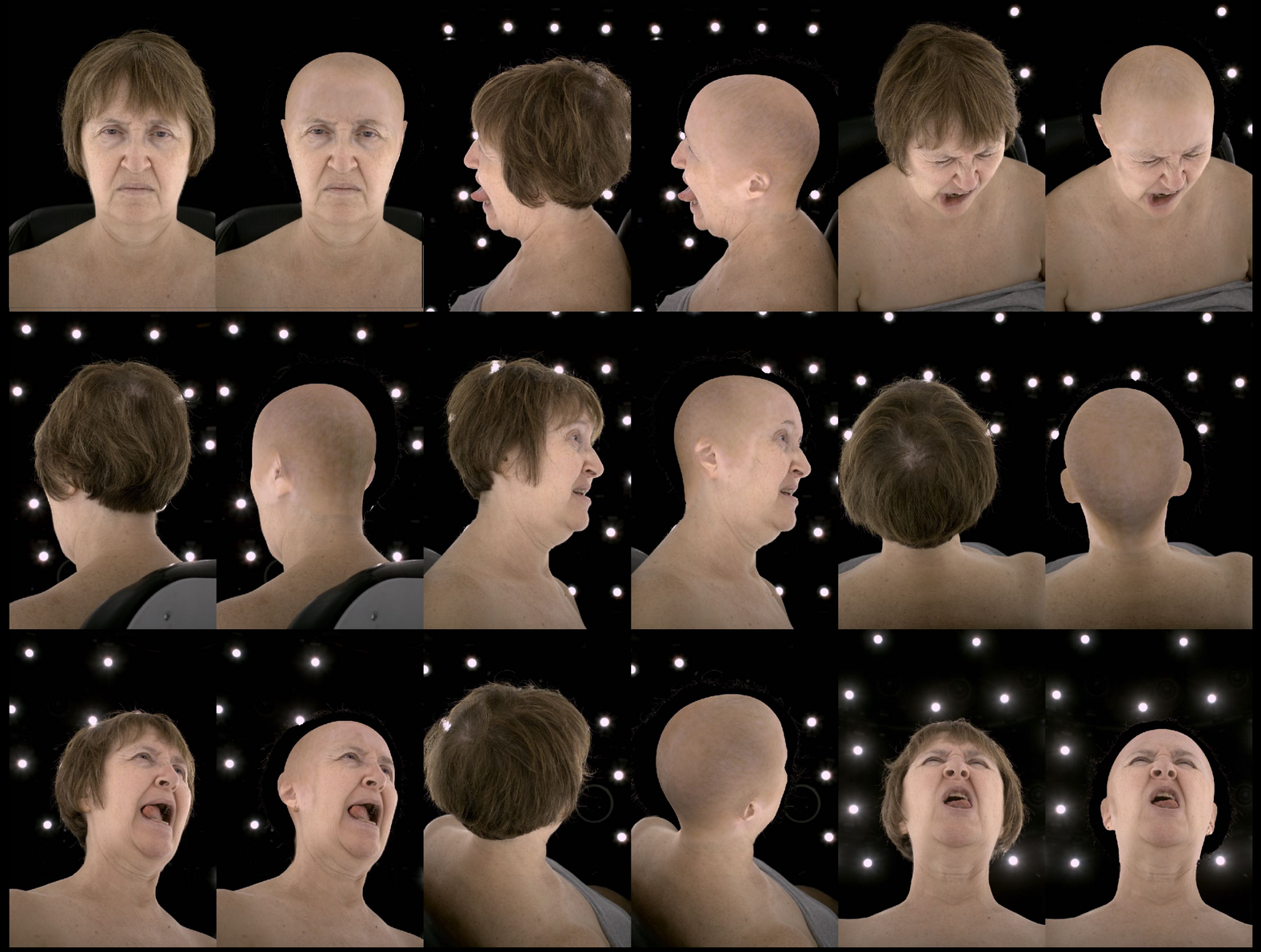
Synthetic Bald Image Generation

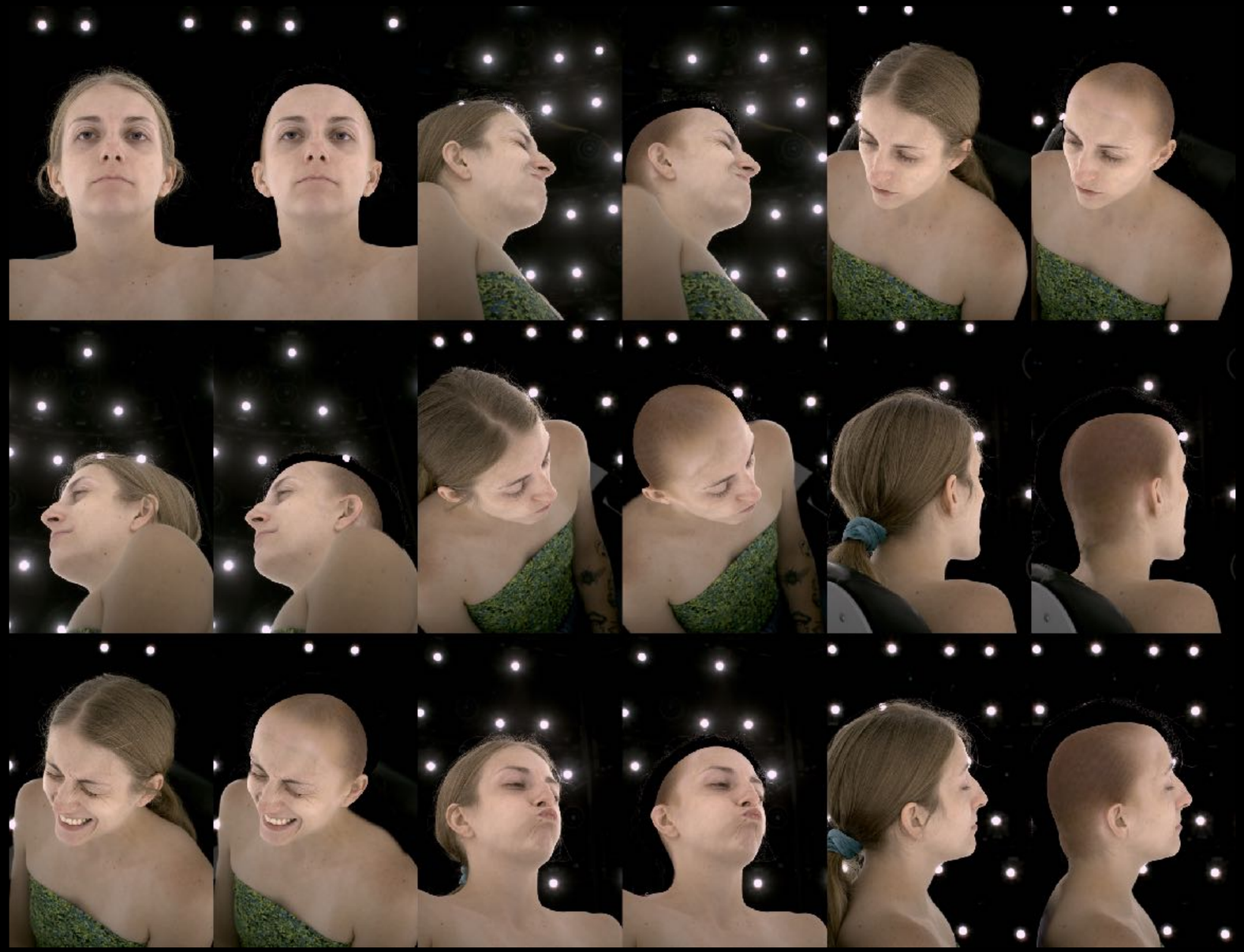
Synthetic Bald Image Generation



Synthetic Bald Image Generation

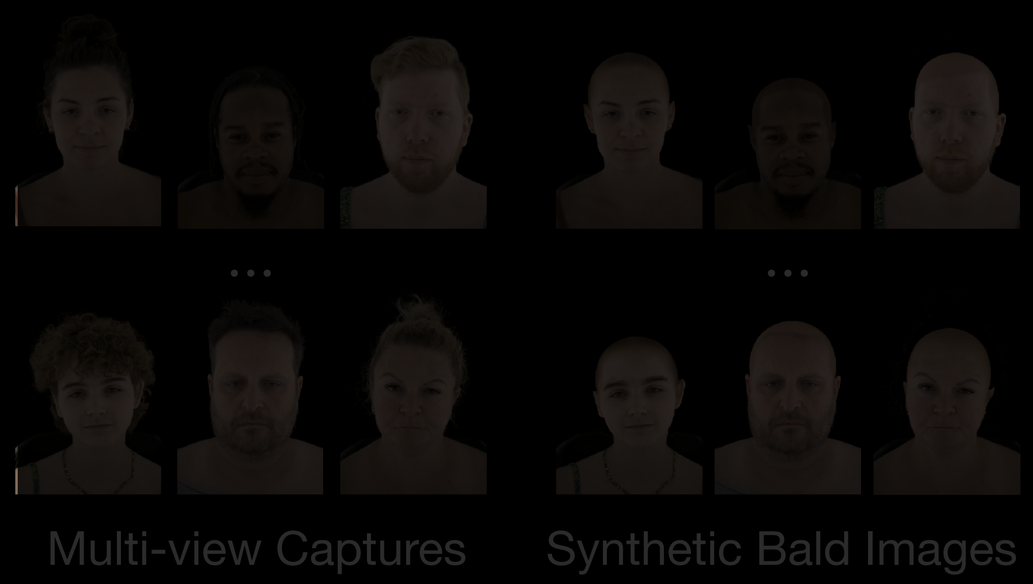
Synthetic Bald Image Generation



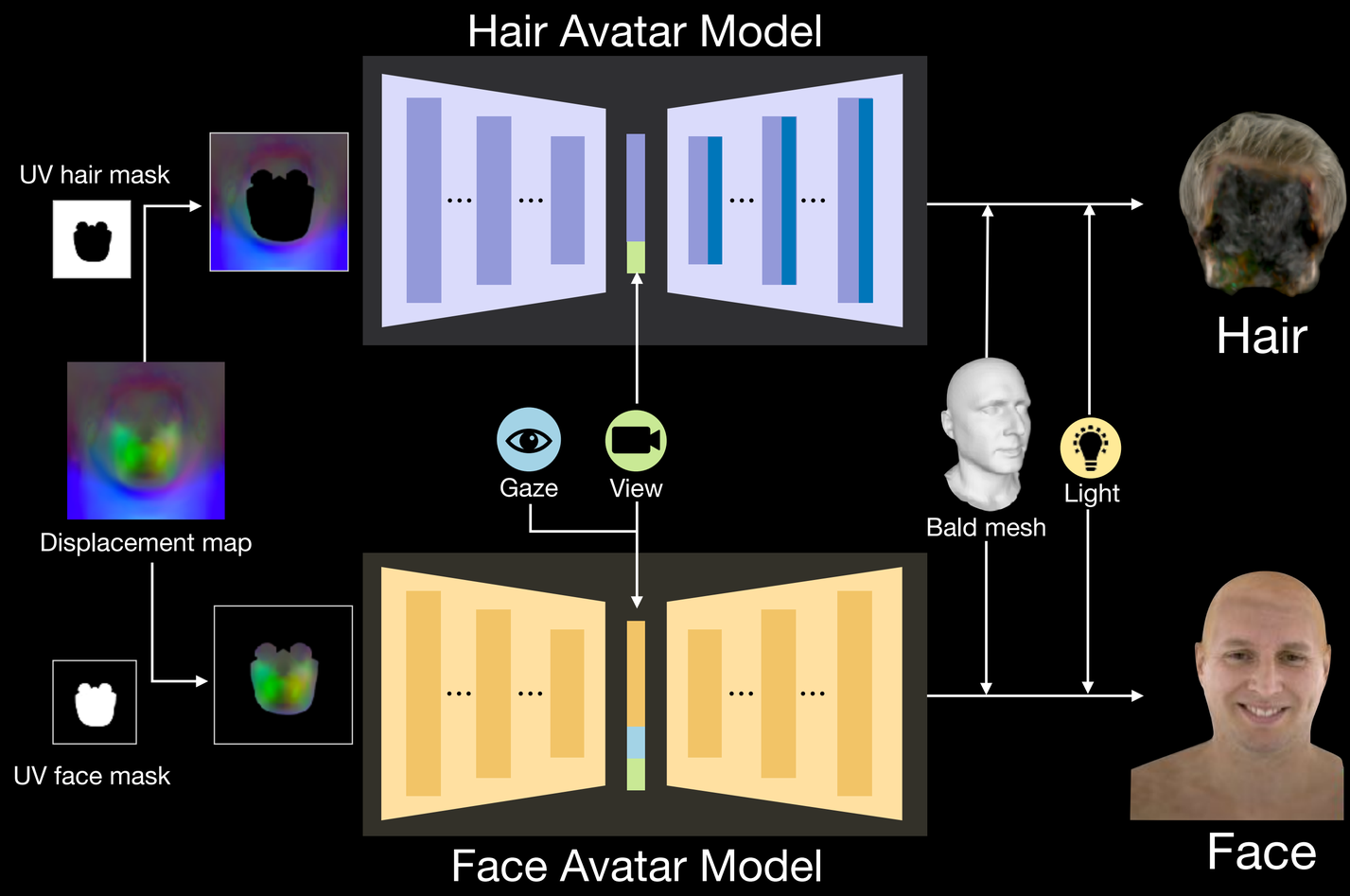


Overview

Compositional Avatar Model



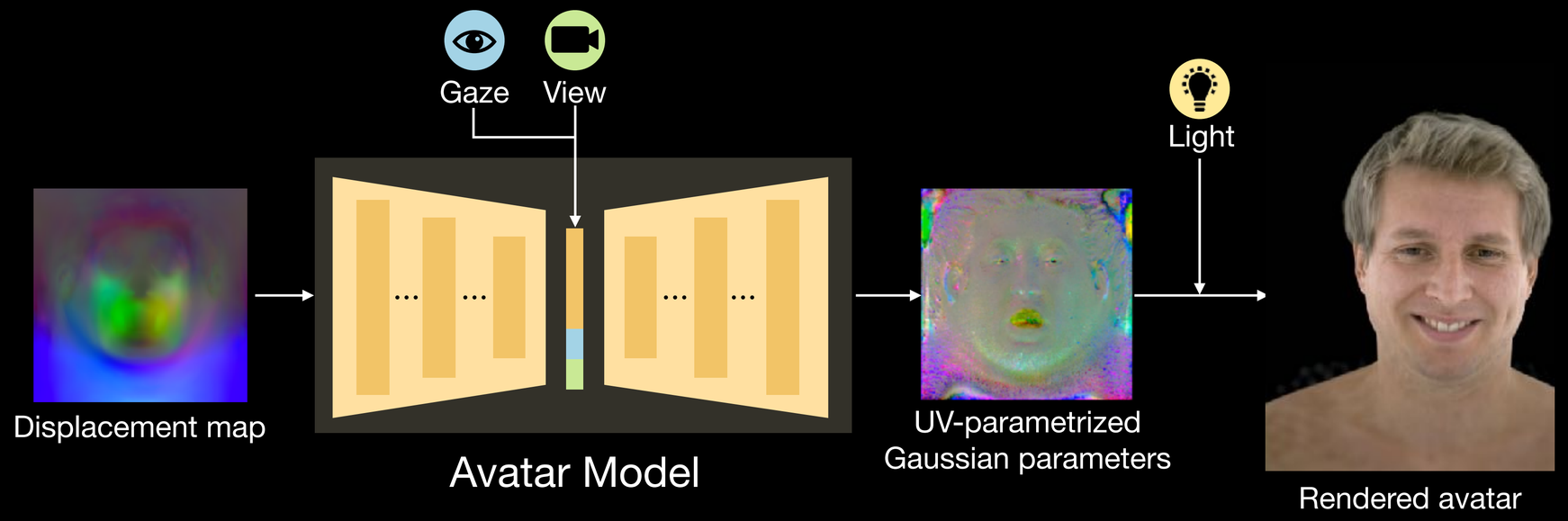
Paired Dataset Construction



Compositional Avatar Model

Compositional Universal Avatar Model

Preliminary: Monolithic Single Avatar Model



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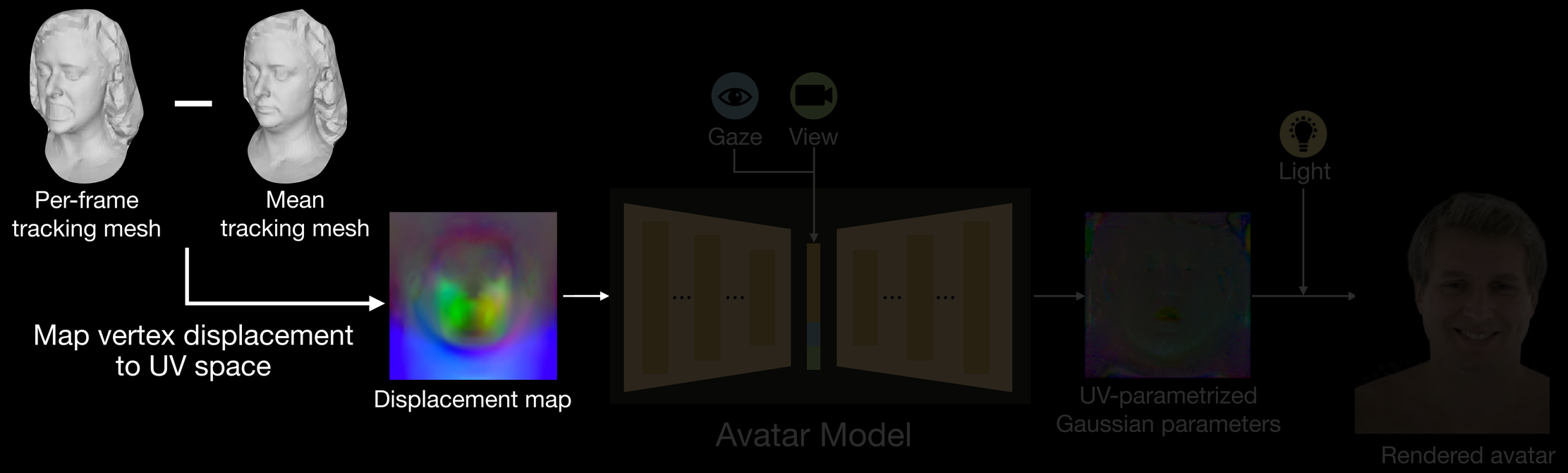

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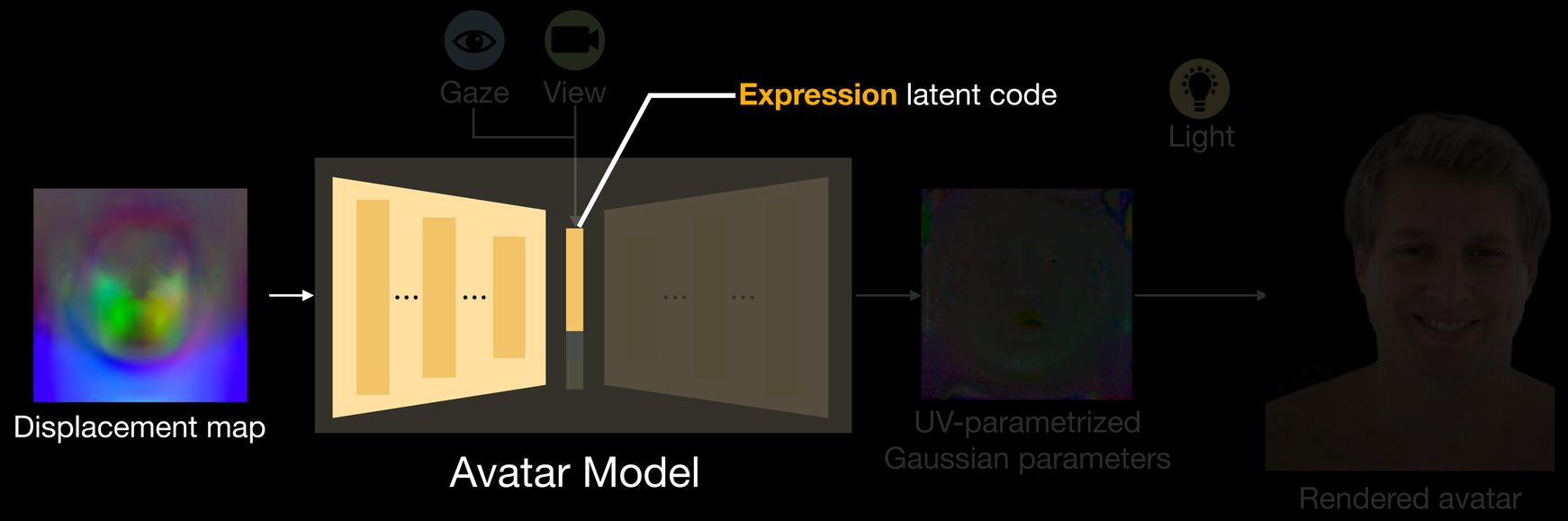

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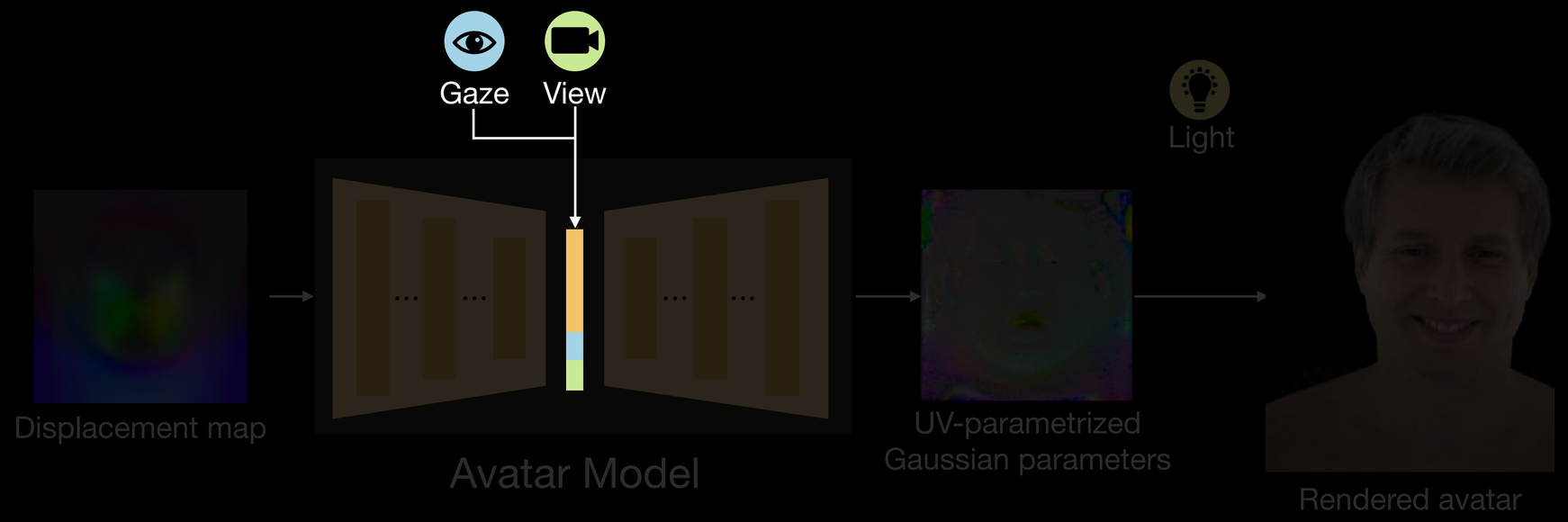
Preliminary: Monolithic Single Avatar Model



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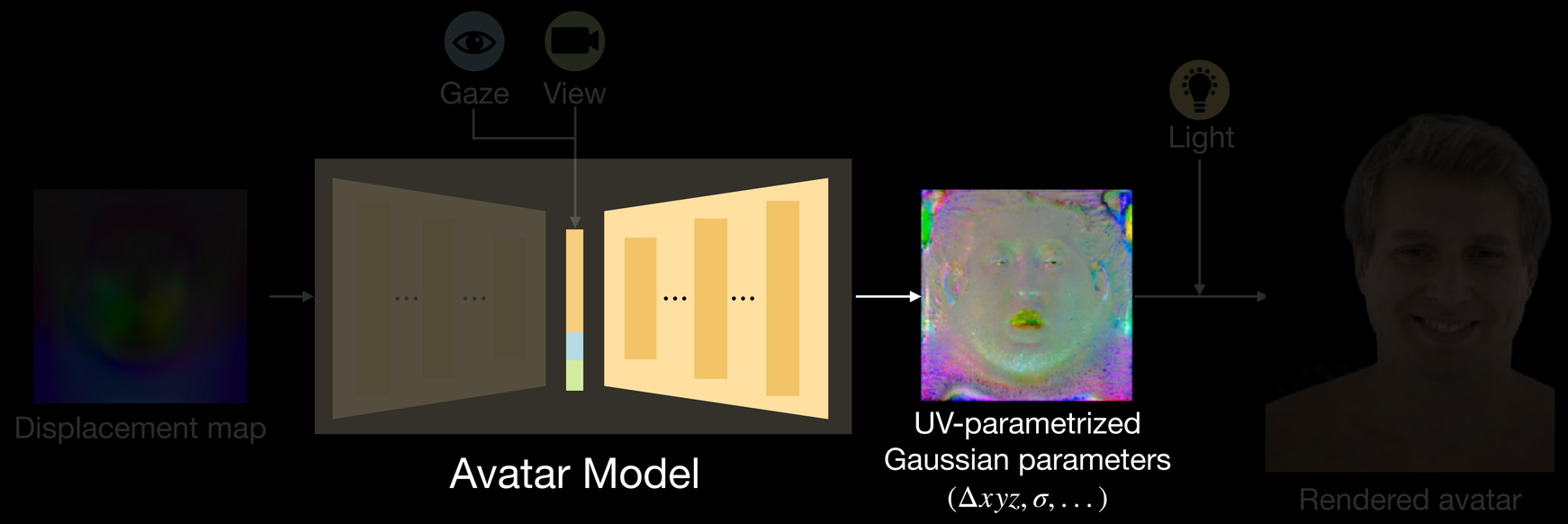

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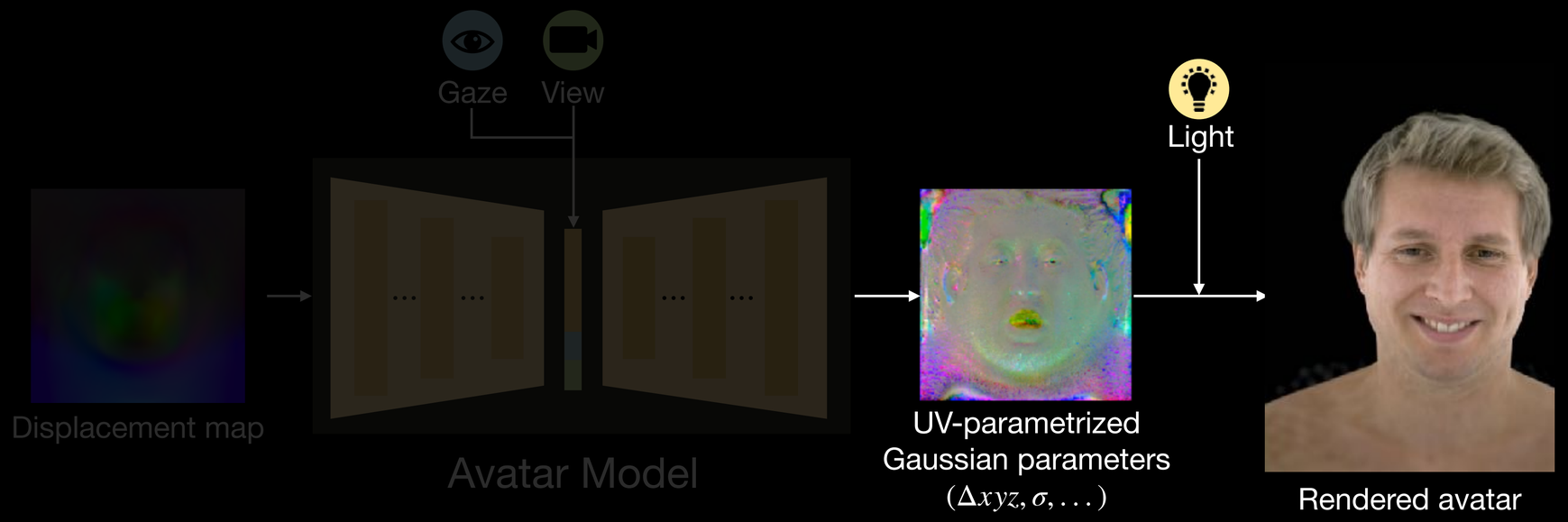

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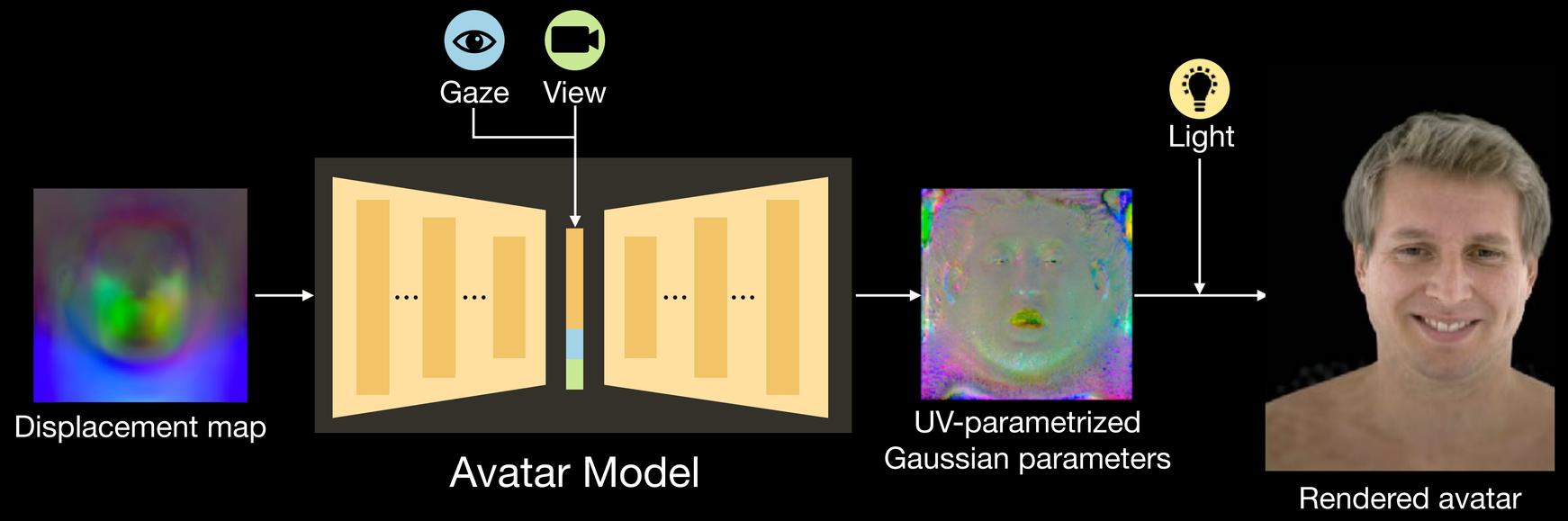
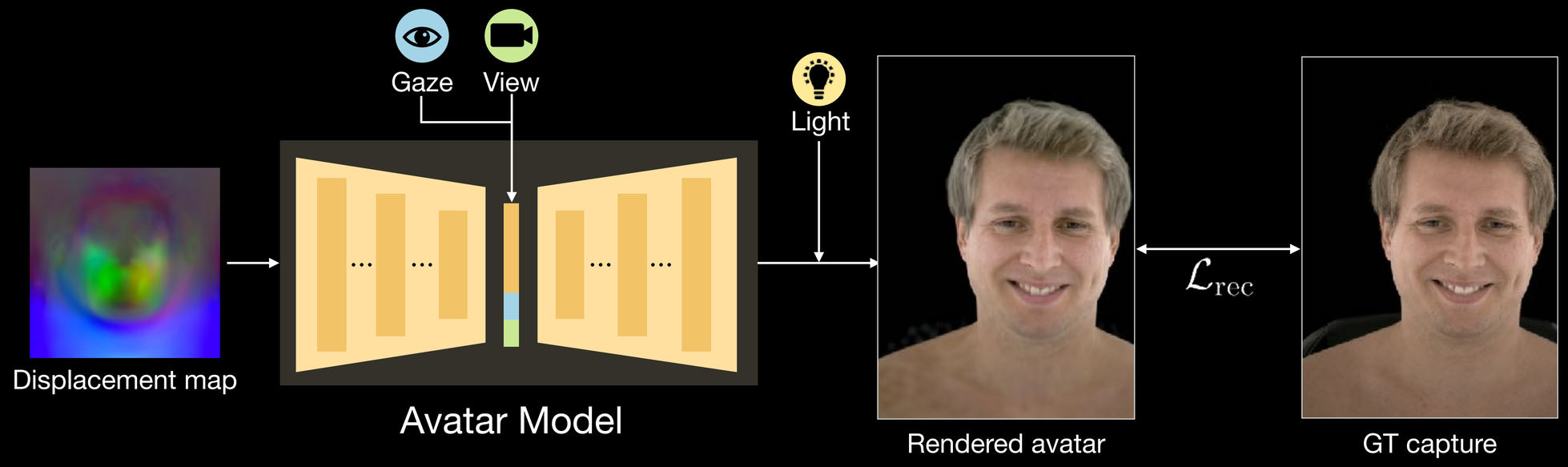


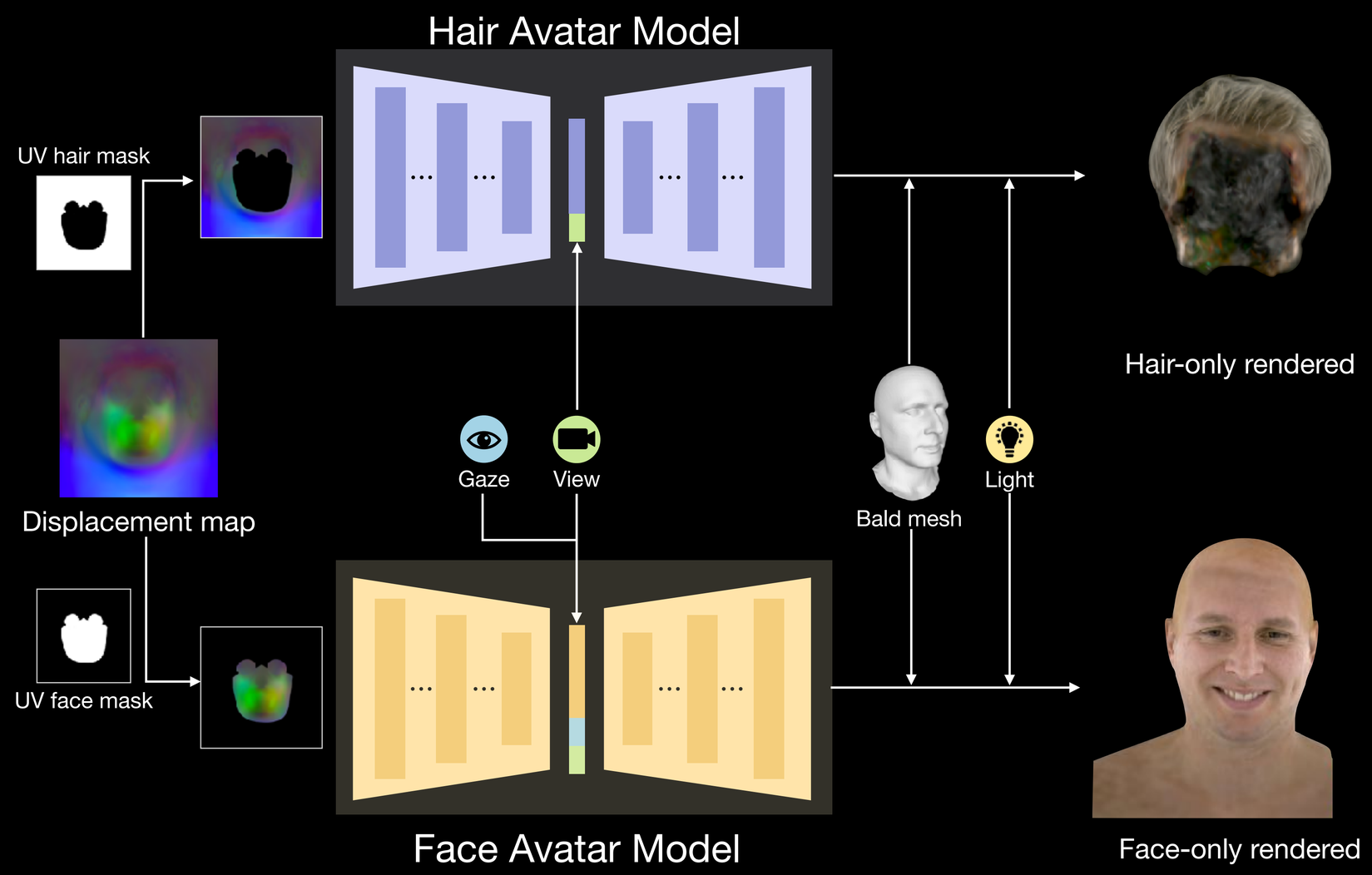
Compositional Universal Avatar Model

Preliminary: Monolithic Single Avatar Model



Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model



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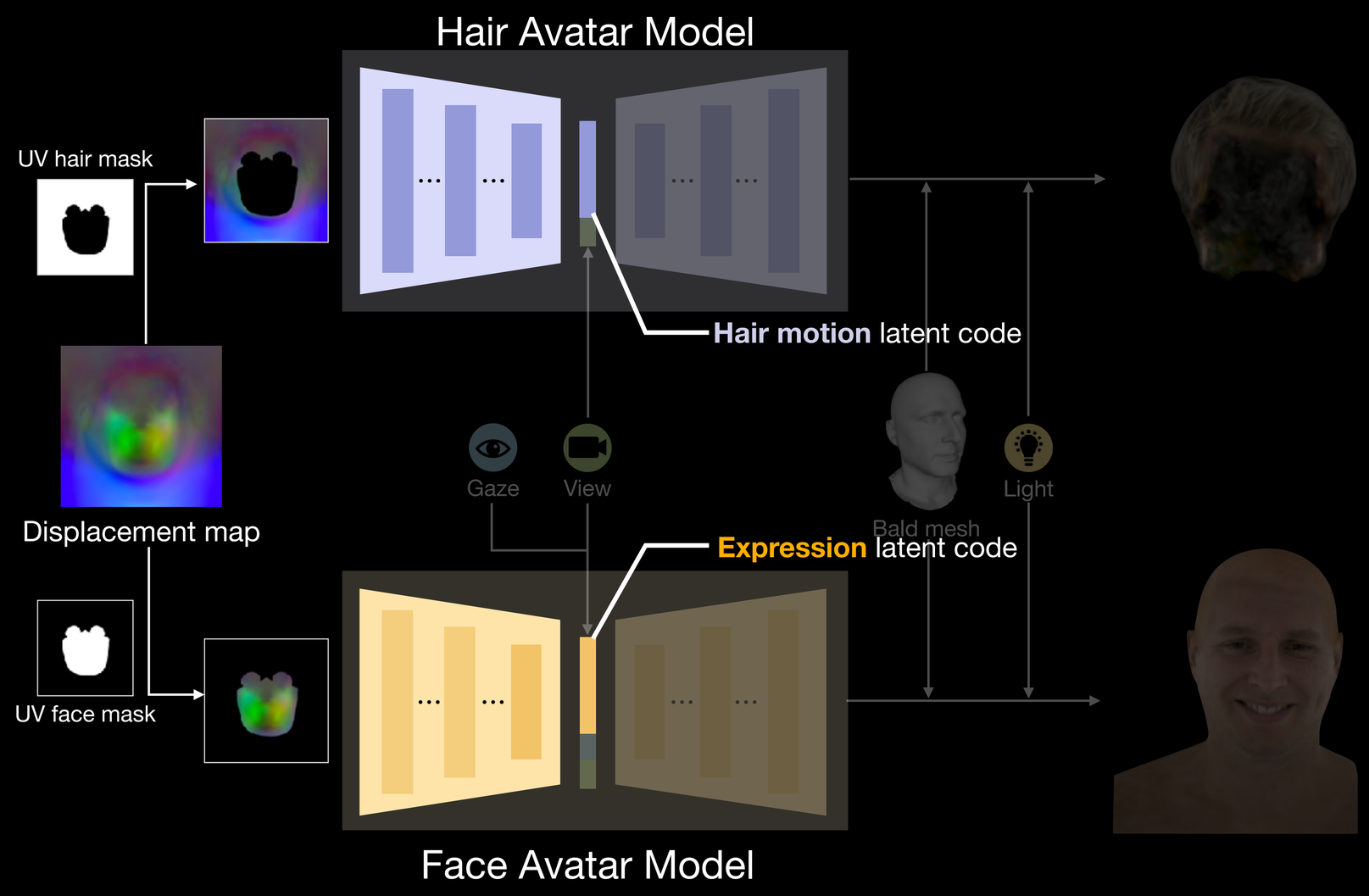

Compositional Universal Avatar Model

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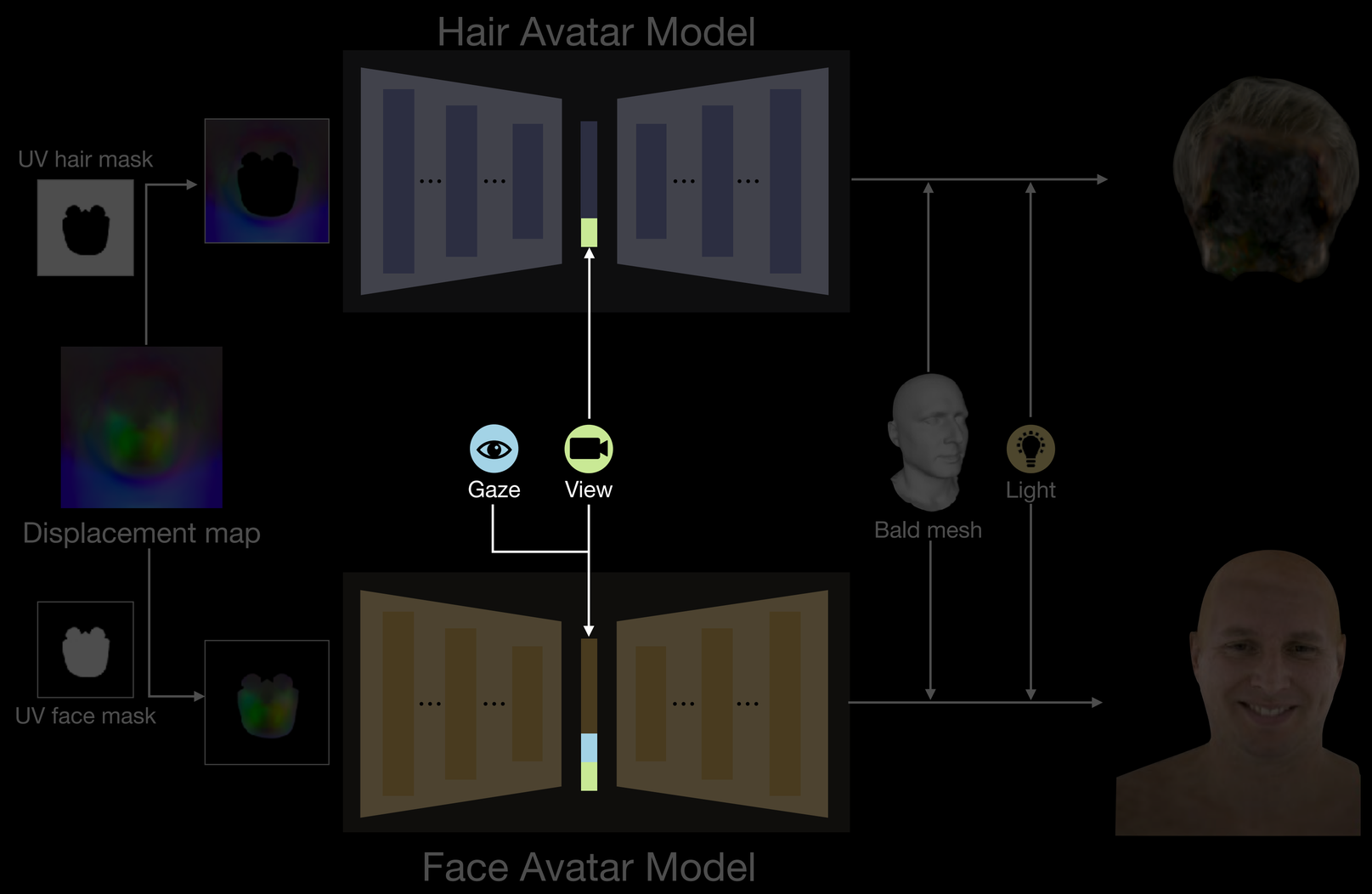
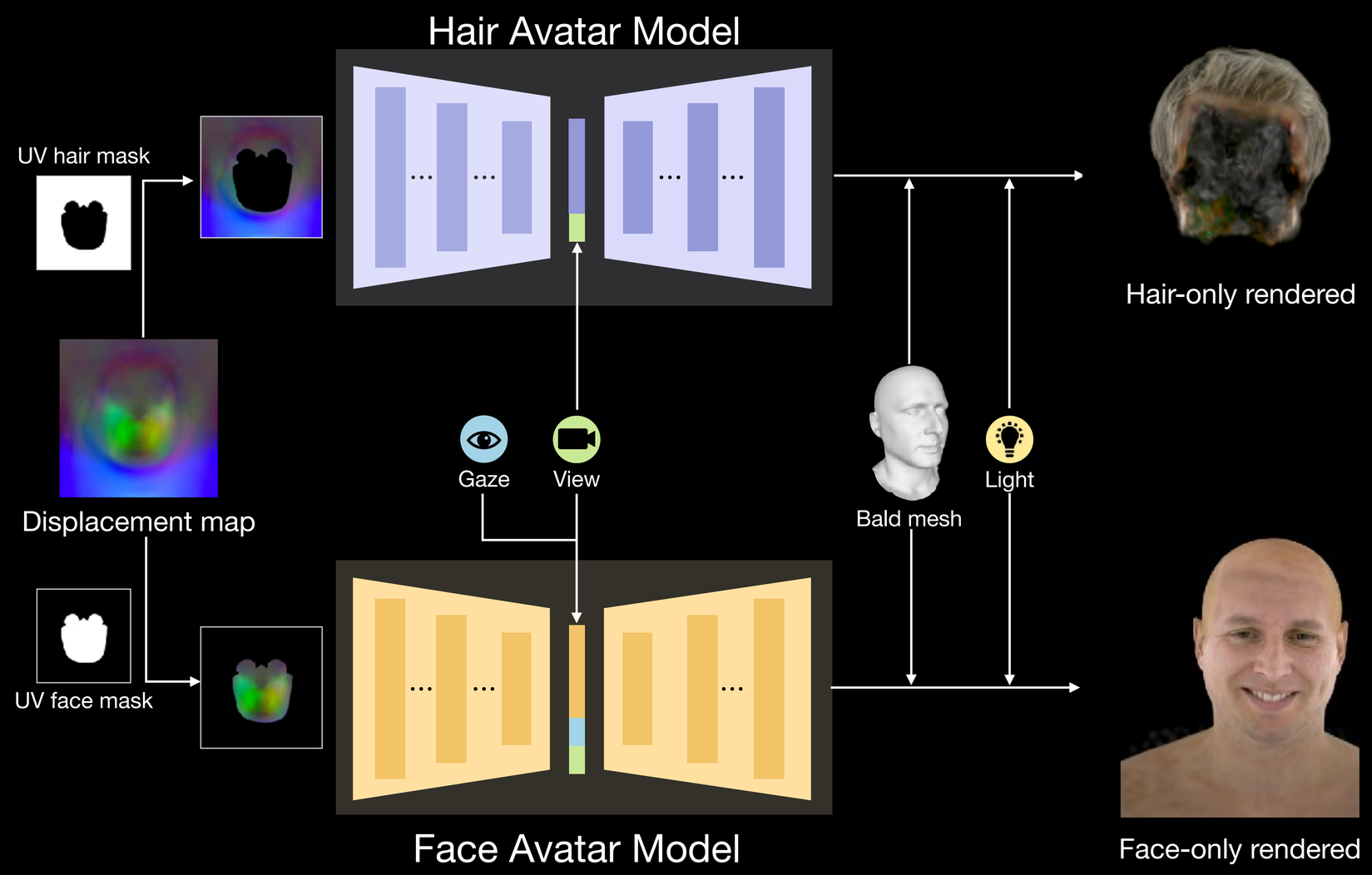


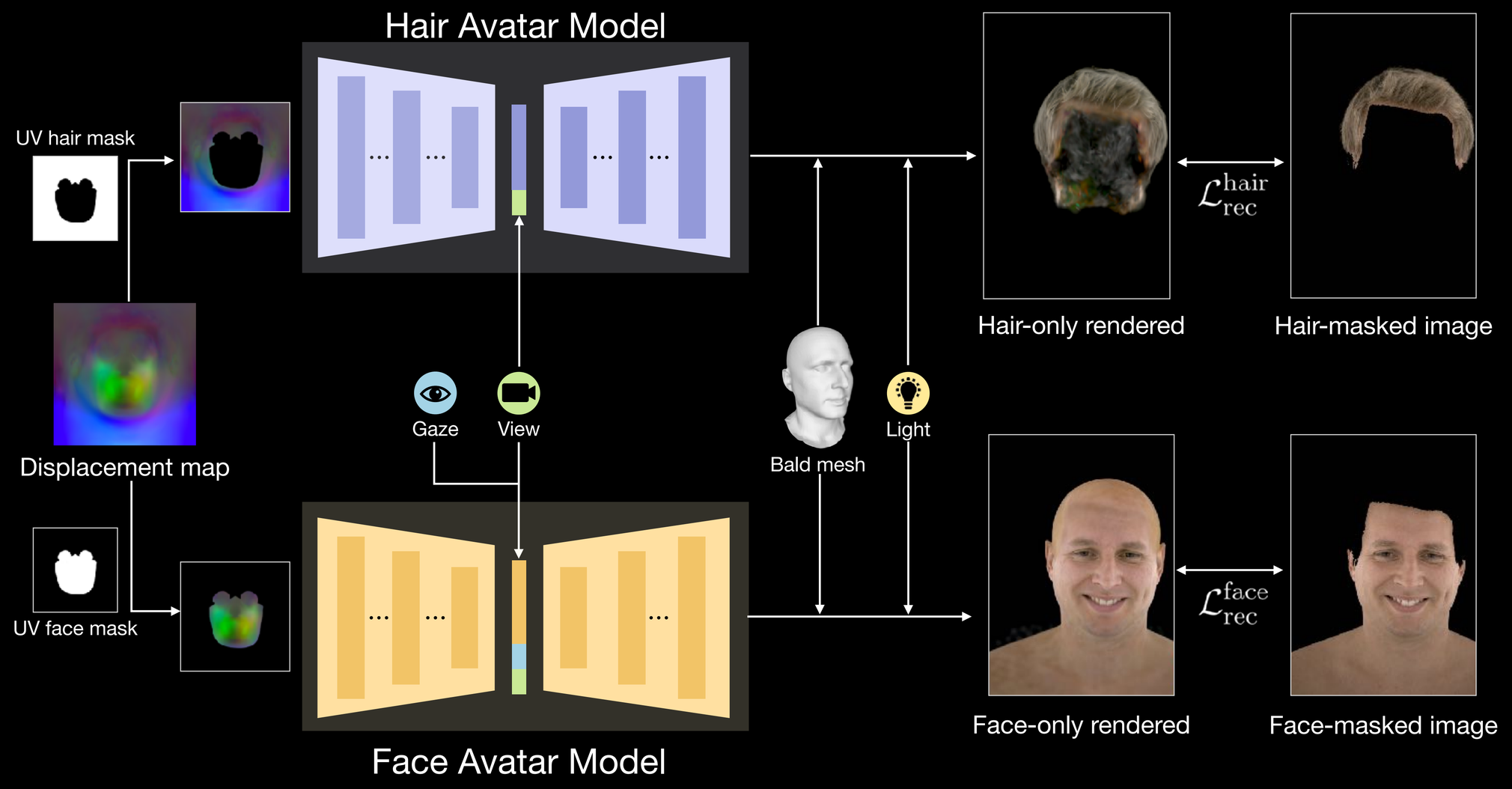
Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model



Compositional Universal Avatar Model

Compositional Single Avatar Model w/o Synthetic Bald Images



Compositional Universal Avatar Model

Results: Compositional Single Avatar Model w/o Synthetic Bald Images

Groundtruth Image | Compositional Avatar | Hair-only | Face-only

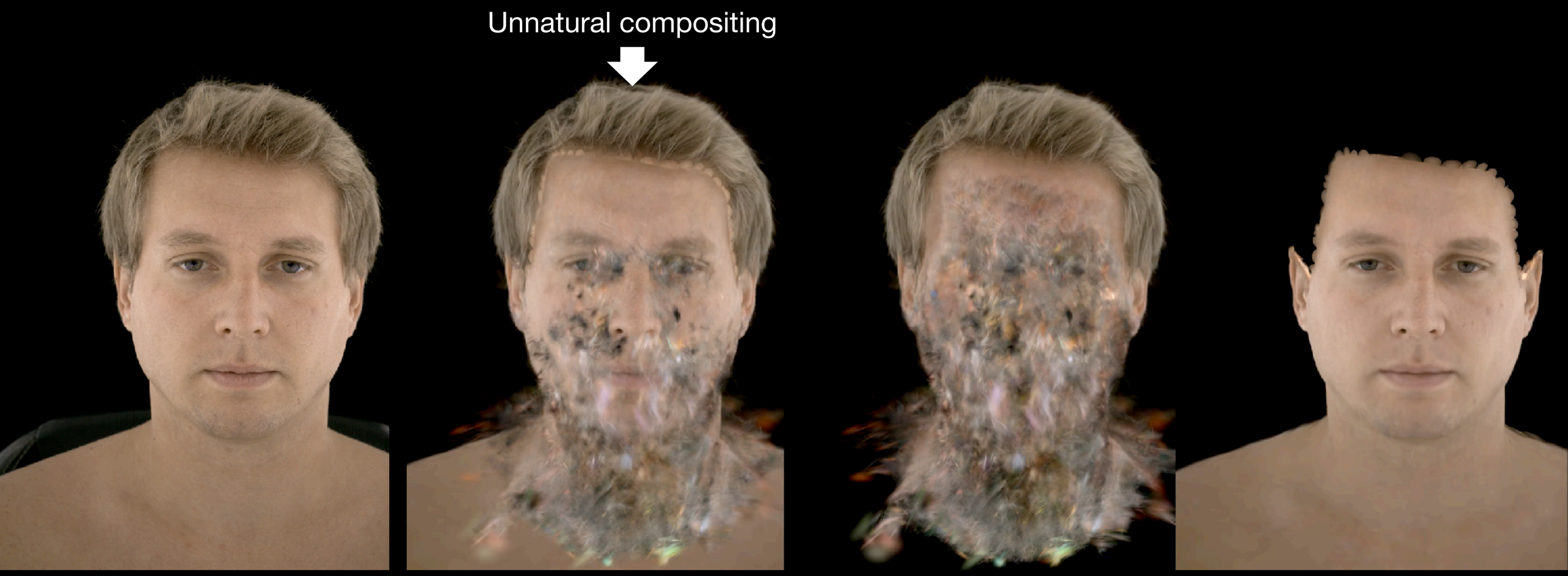
Compositional Universal Avatar Model

Results: Compositional Single Avatar Model w/o Synthetic Bald Images

Groundtruth Image | Compositional Avatar | Hair-only | Face-only

Compositional Universal Avatar Model

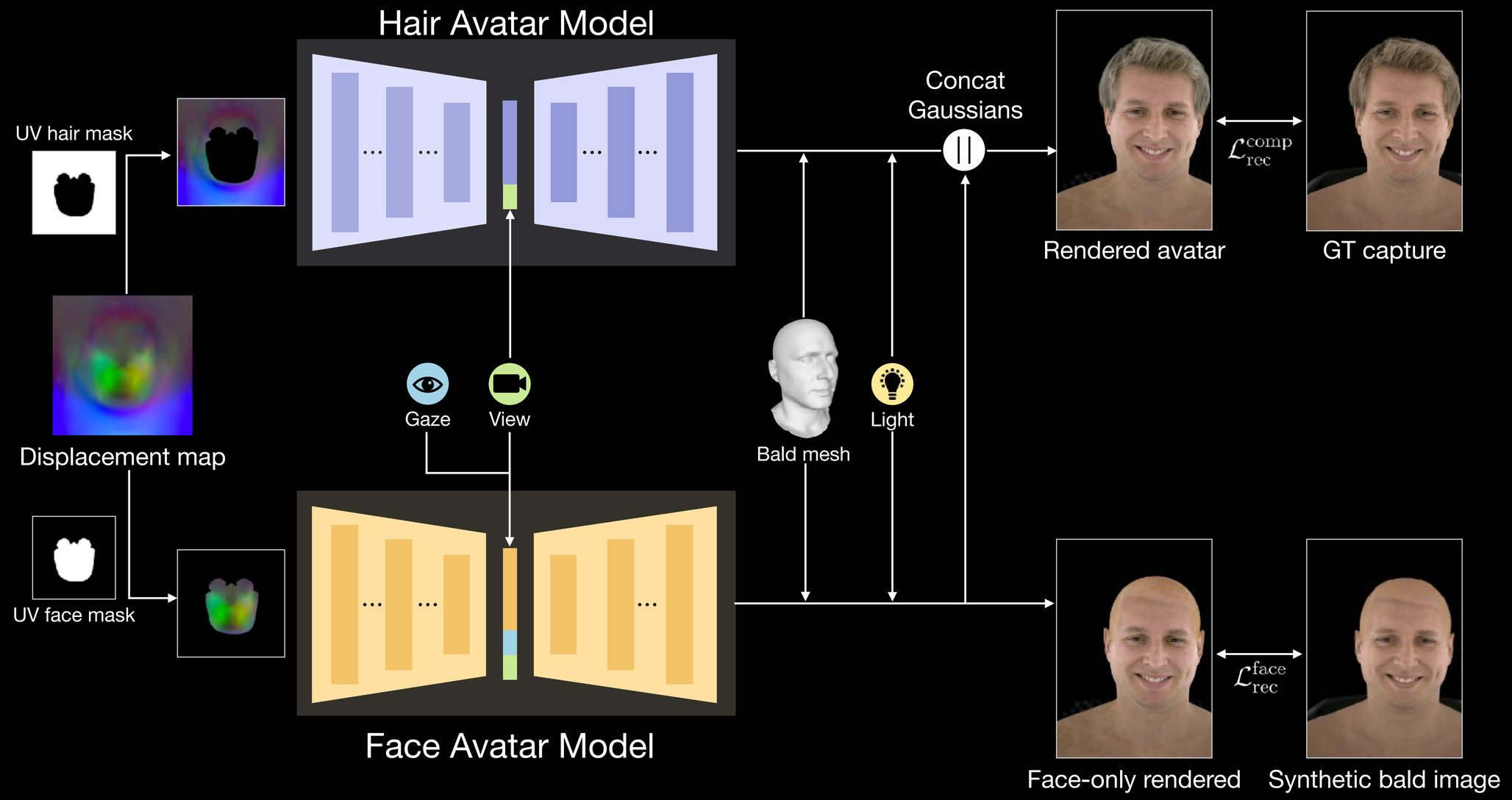
Results: Compositional Single Avatar Model w/o Synthetic Bald Images



Groundtruth Image | Compositional Avatar | Hair-only | Face-only

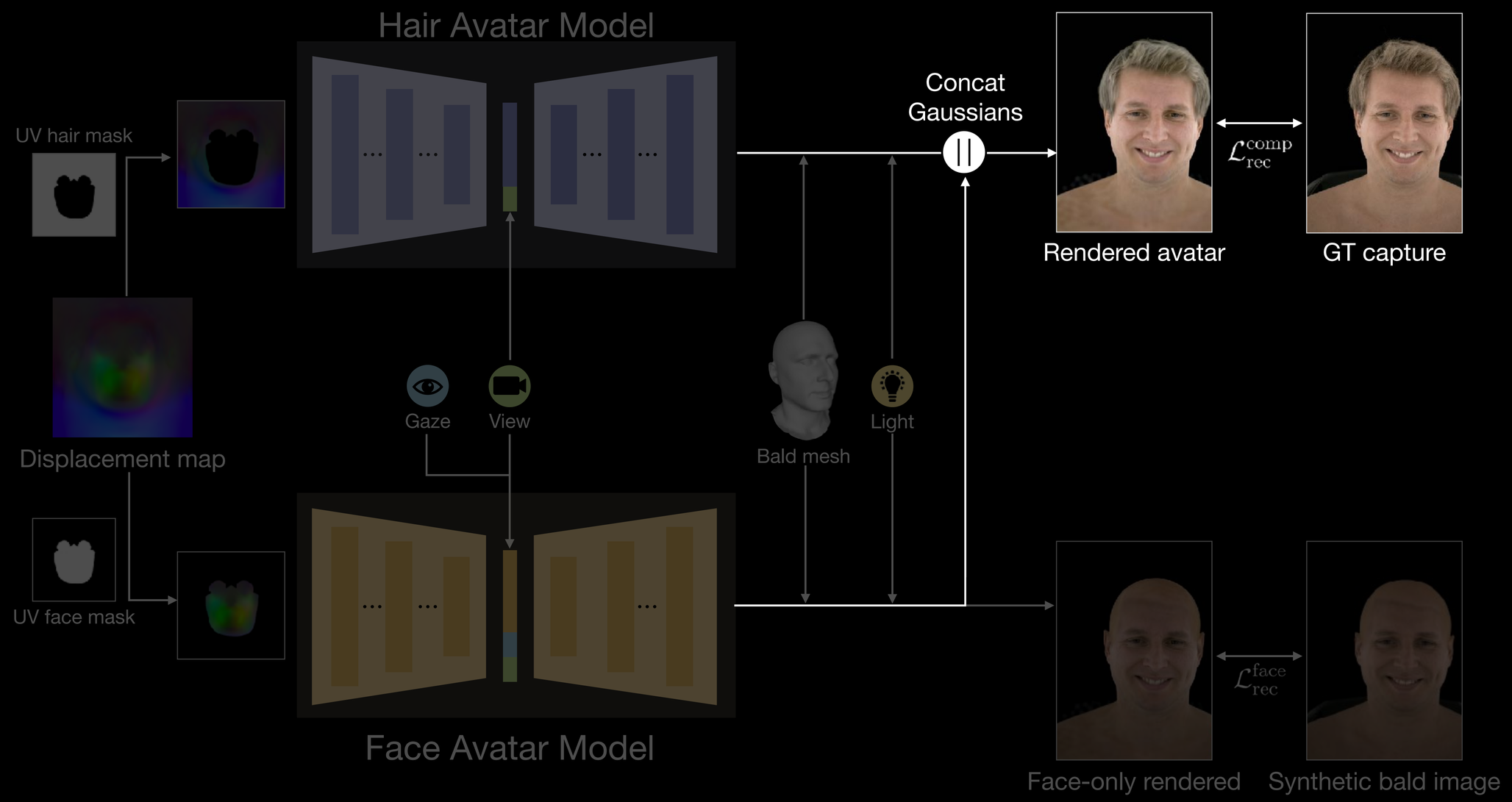
Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model with Synthetic Bald Images



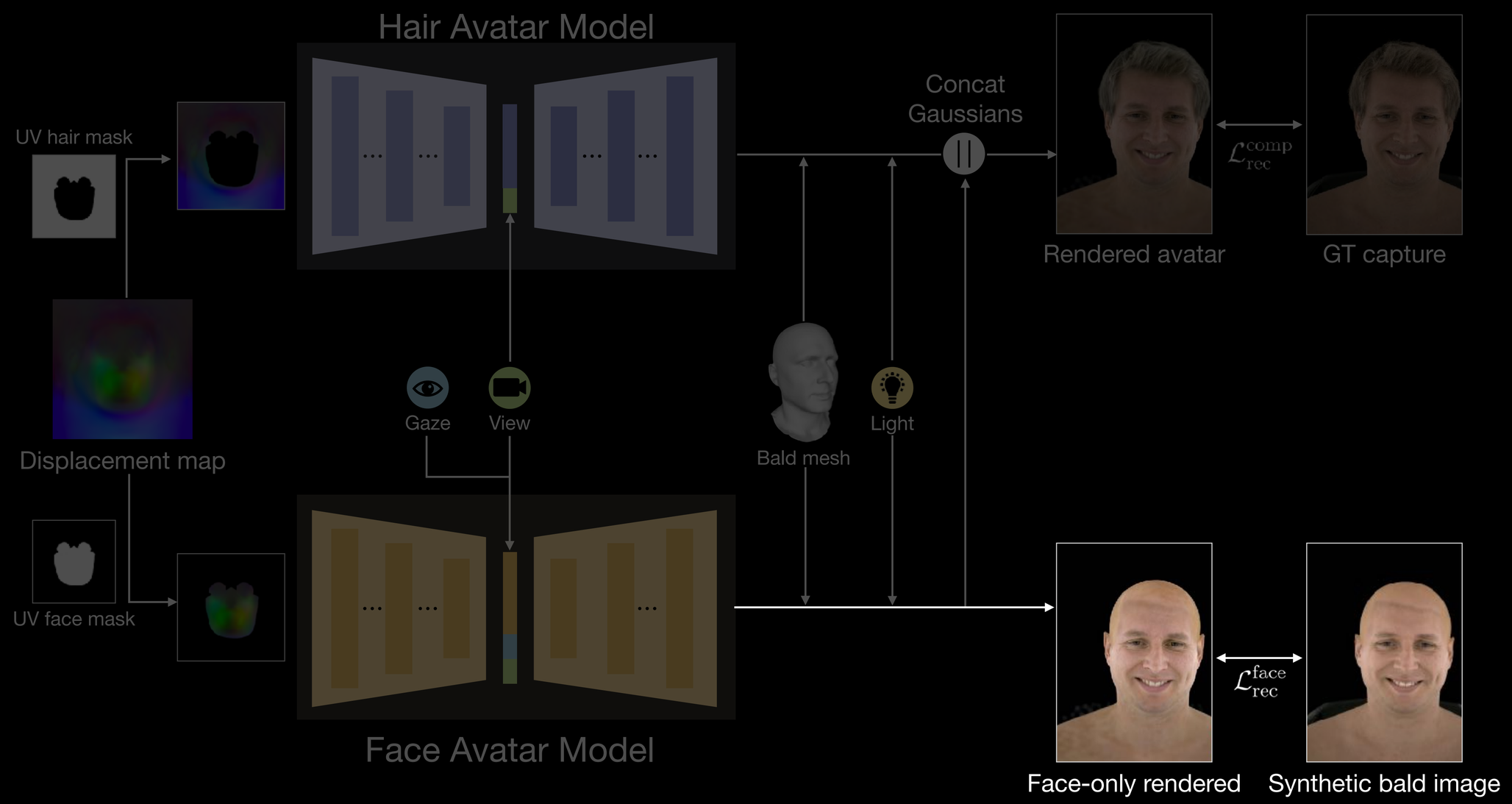
Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model with Synthetic Bald Images



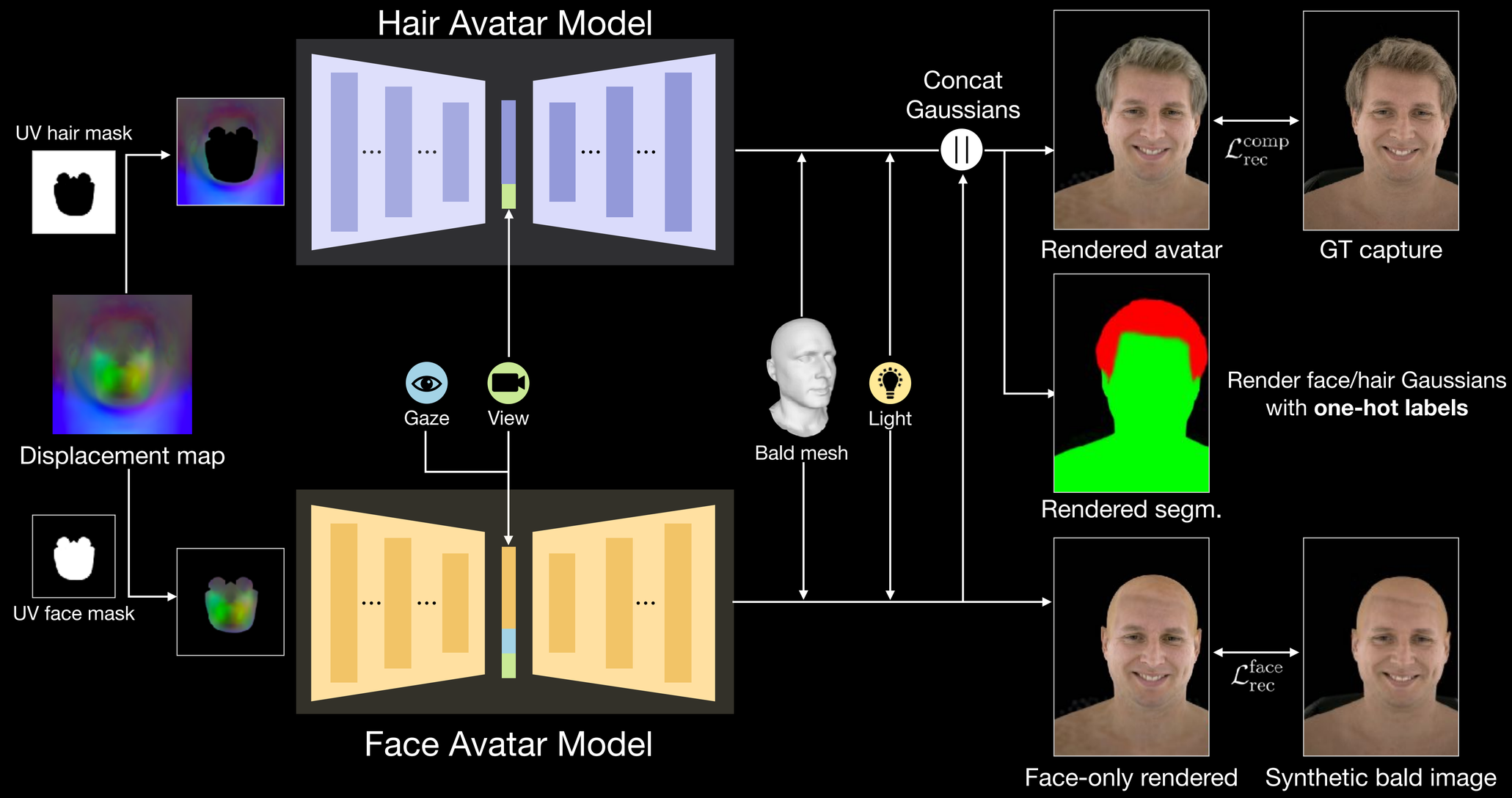
Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model with Synthetic Bald Images



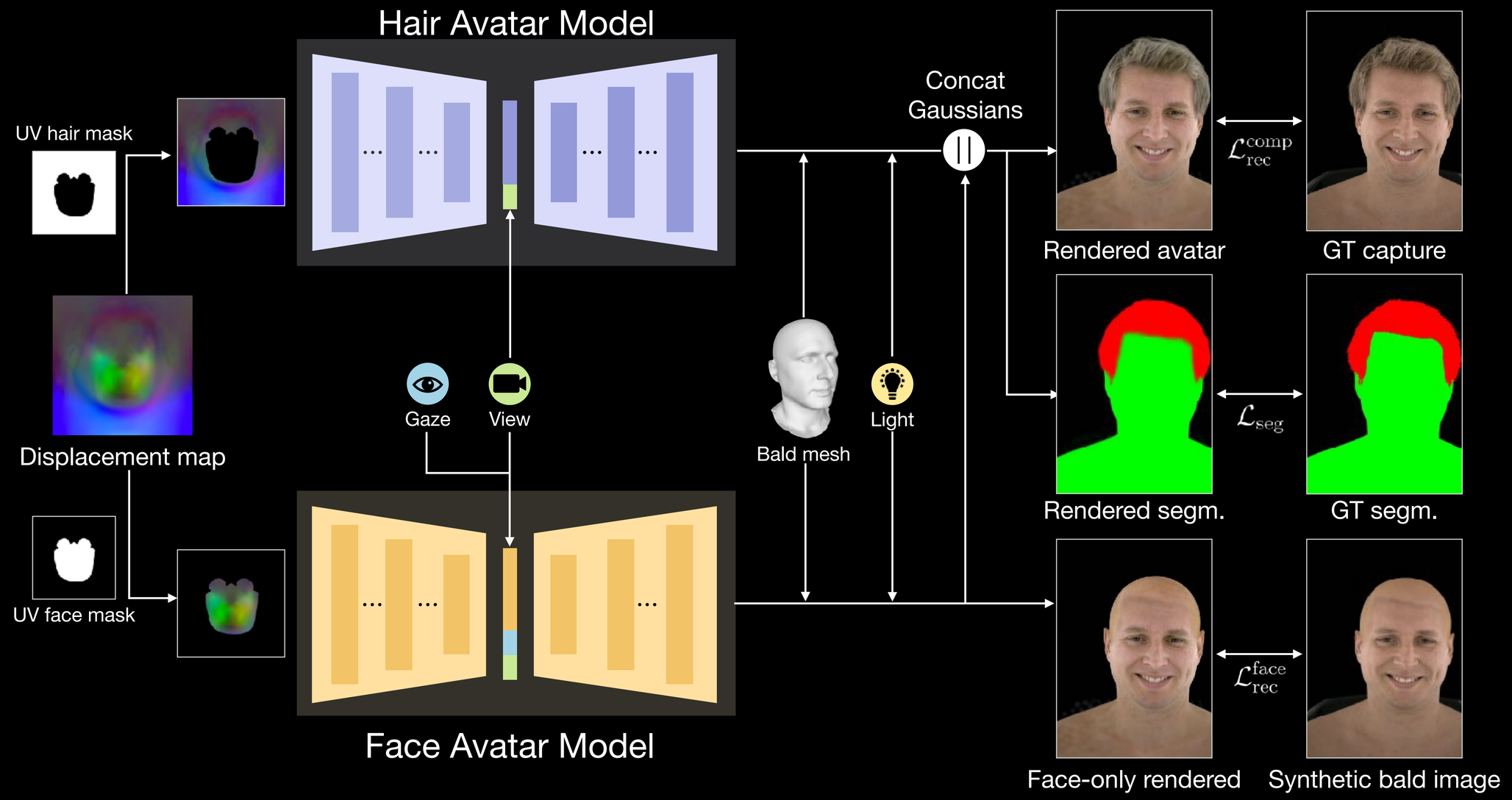
Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model with Synthetic Bald Images



Compositional Universal Avatar Model

Ours: Compositional Single Avatar Model with Synthetic Bald Images



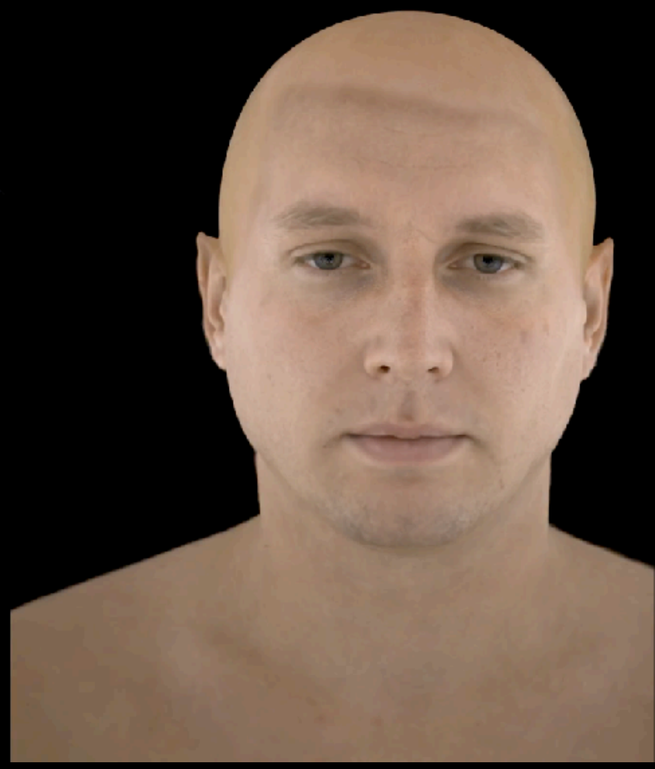
Compositional Universal Avatar Model

Results: Compositional Single Avatar Model with Synthetic Bald Images

Groundtruth Image

Compositional Avatar

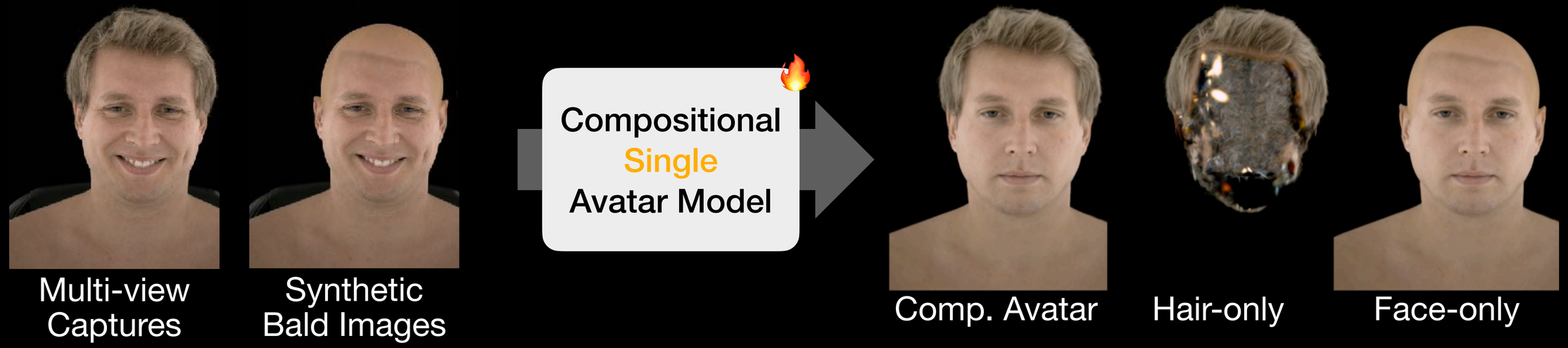
Hair-only



Face-only

Compositional Universal Avatar Model

Towards Compositional Universal Avatar Model

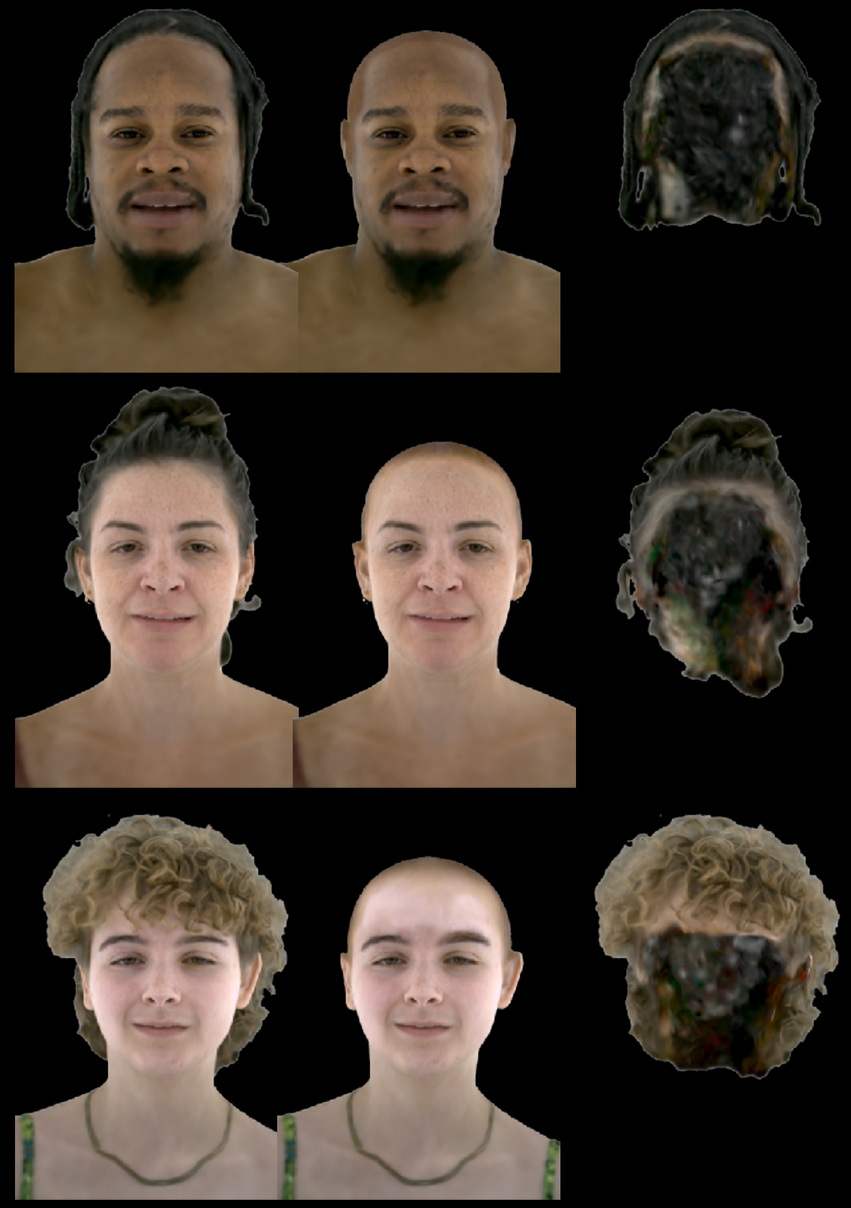


Compositional Universal Avatar Model

Towards Compositional Universal Avatar Model

Multi-view Captures Synthetic Bald Images

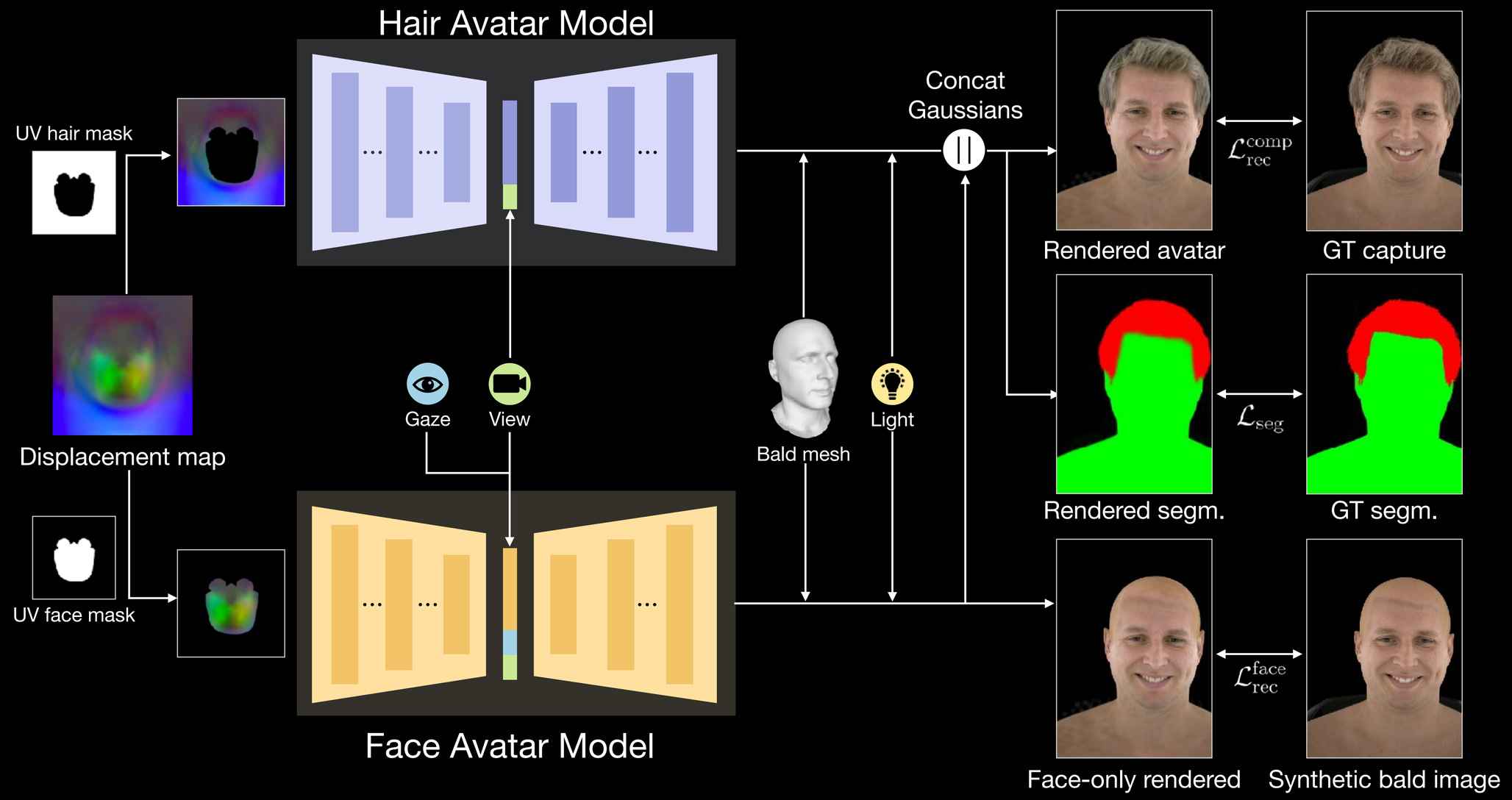
Compositional
Universal
Avatar Model



Comp. Avatar Hair-only Face-only

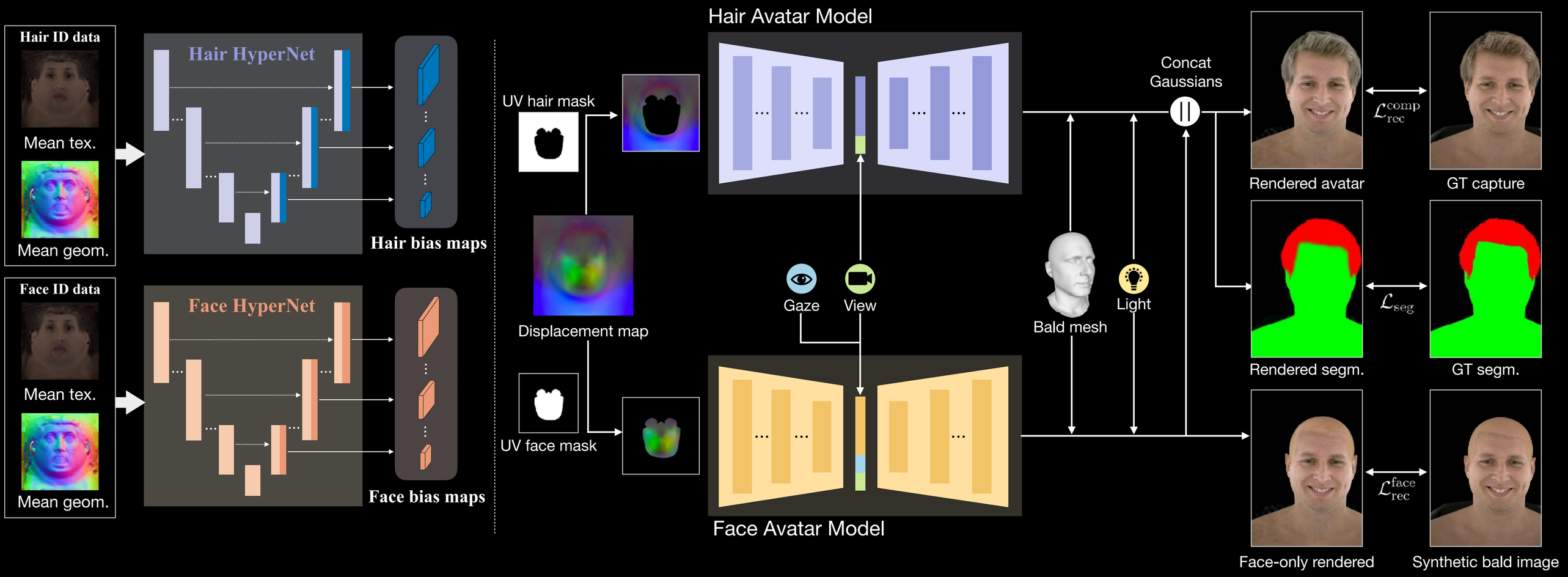
Compositional Universal Avatar Model

Compositional Single Avatar Model



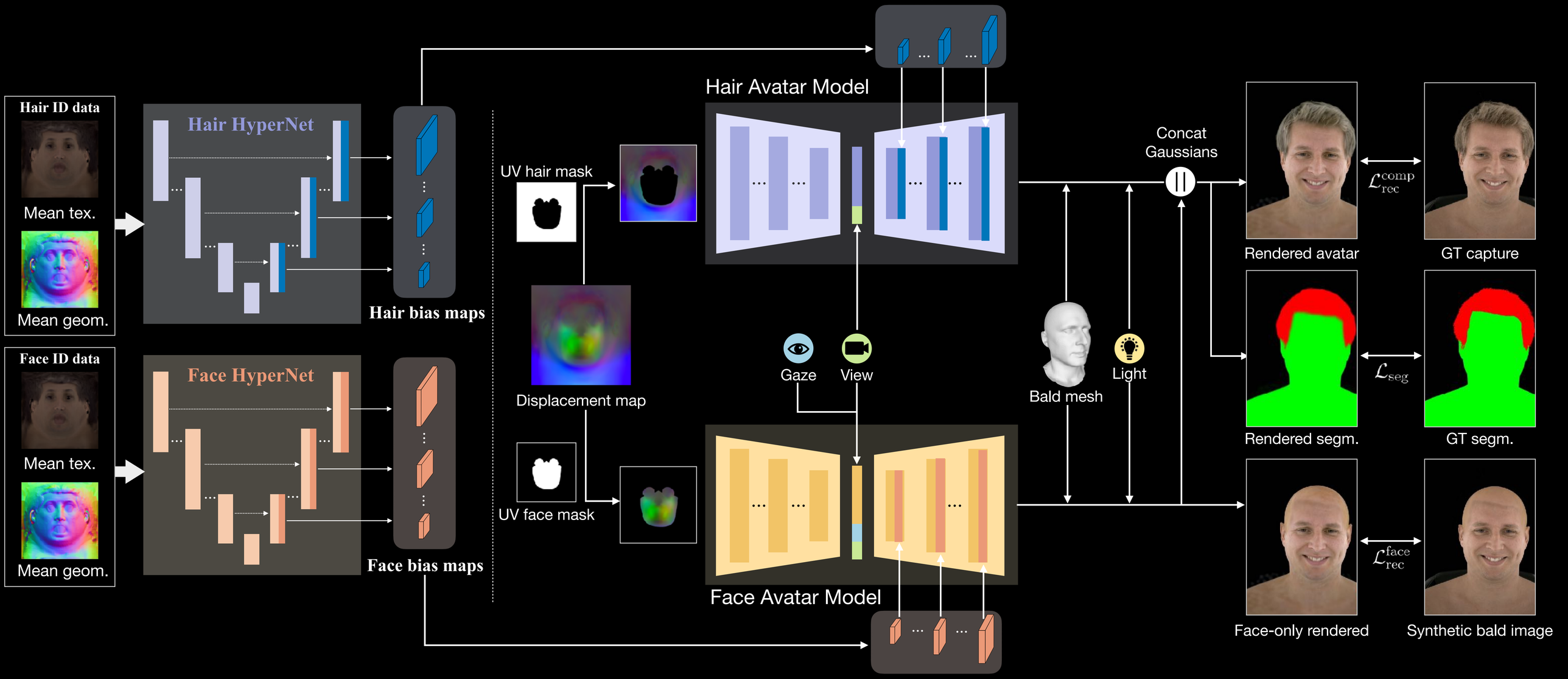
Compositional Universal Avatar Model

Compositional Universal Avatar Model with HyperNets



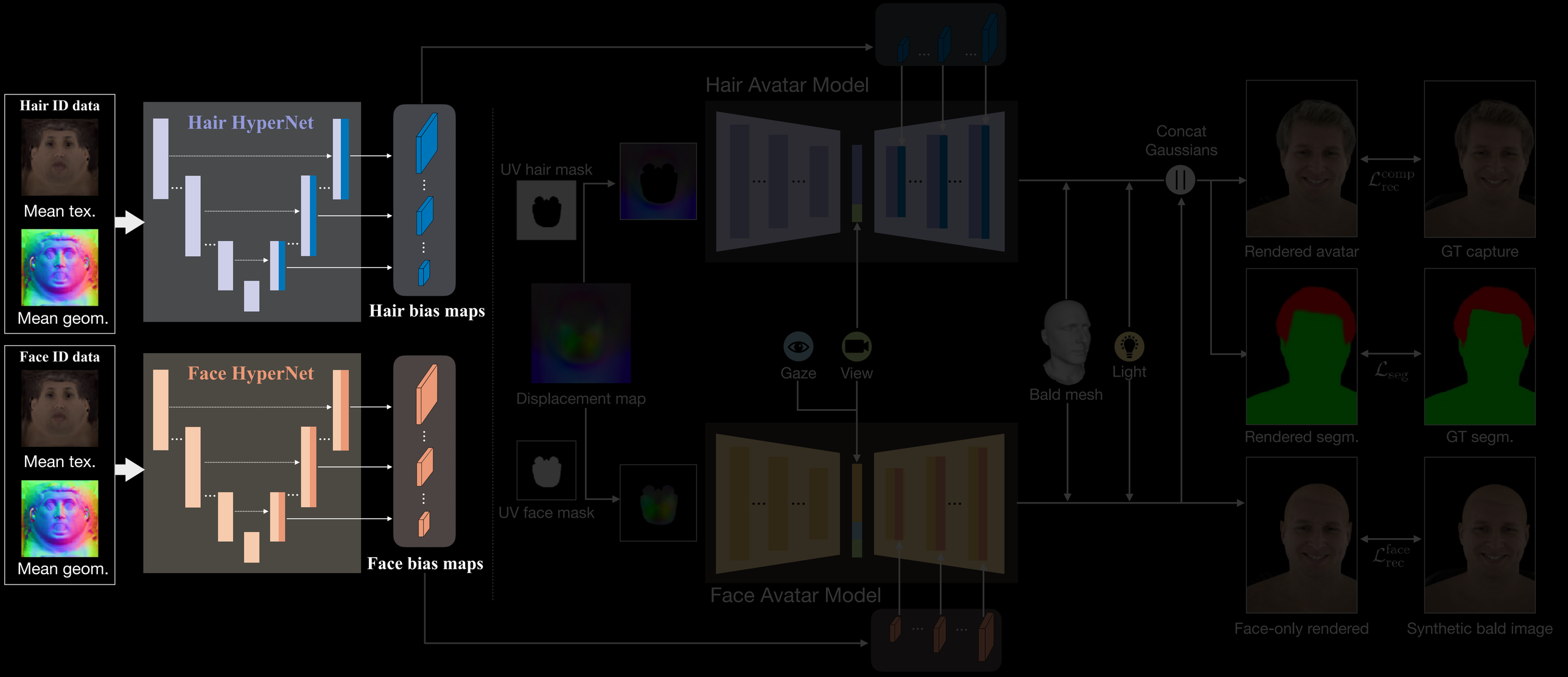
Compositional Universal Avatar Model

Compositional Universal Avatar Model with HyperNets



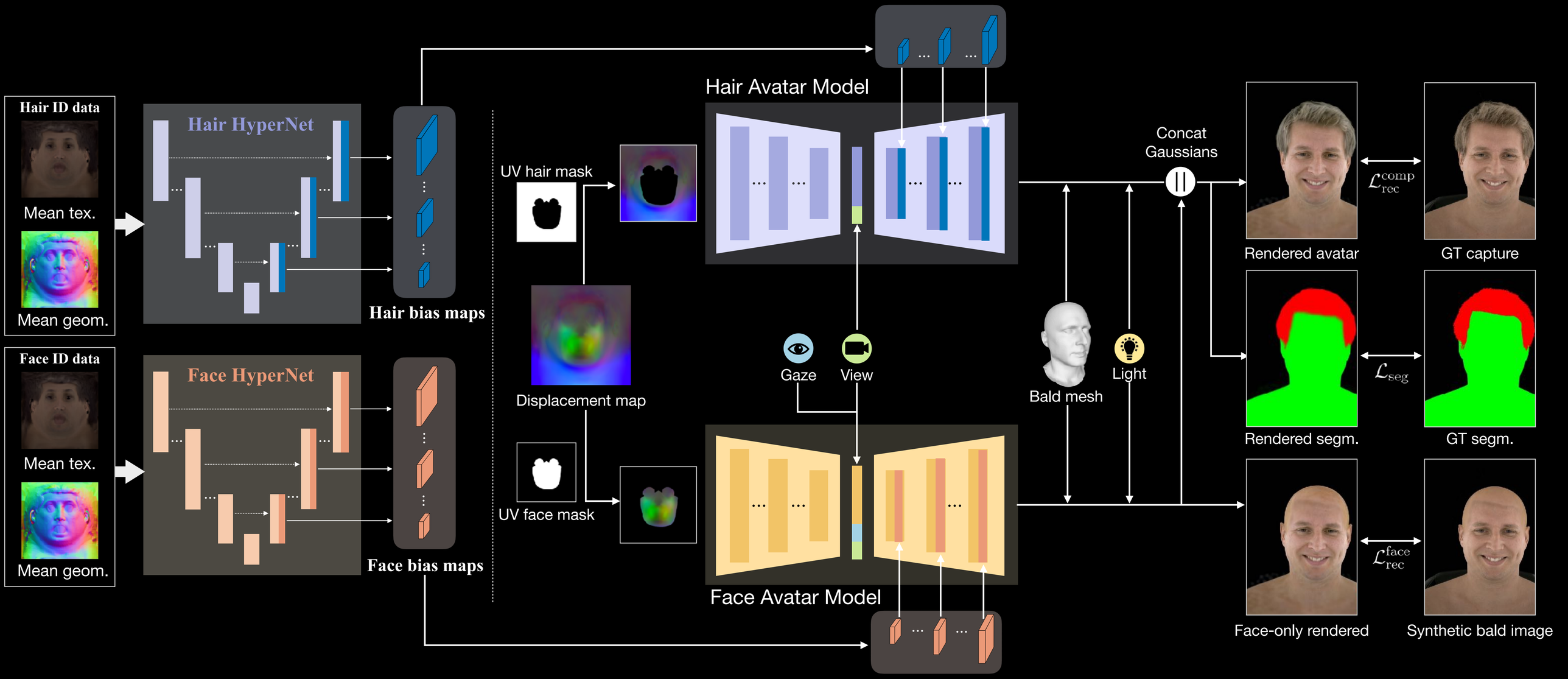
Compositional Universal Avatar Model

Compositional Universal Avatar Model with HyperNets



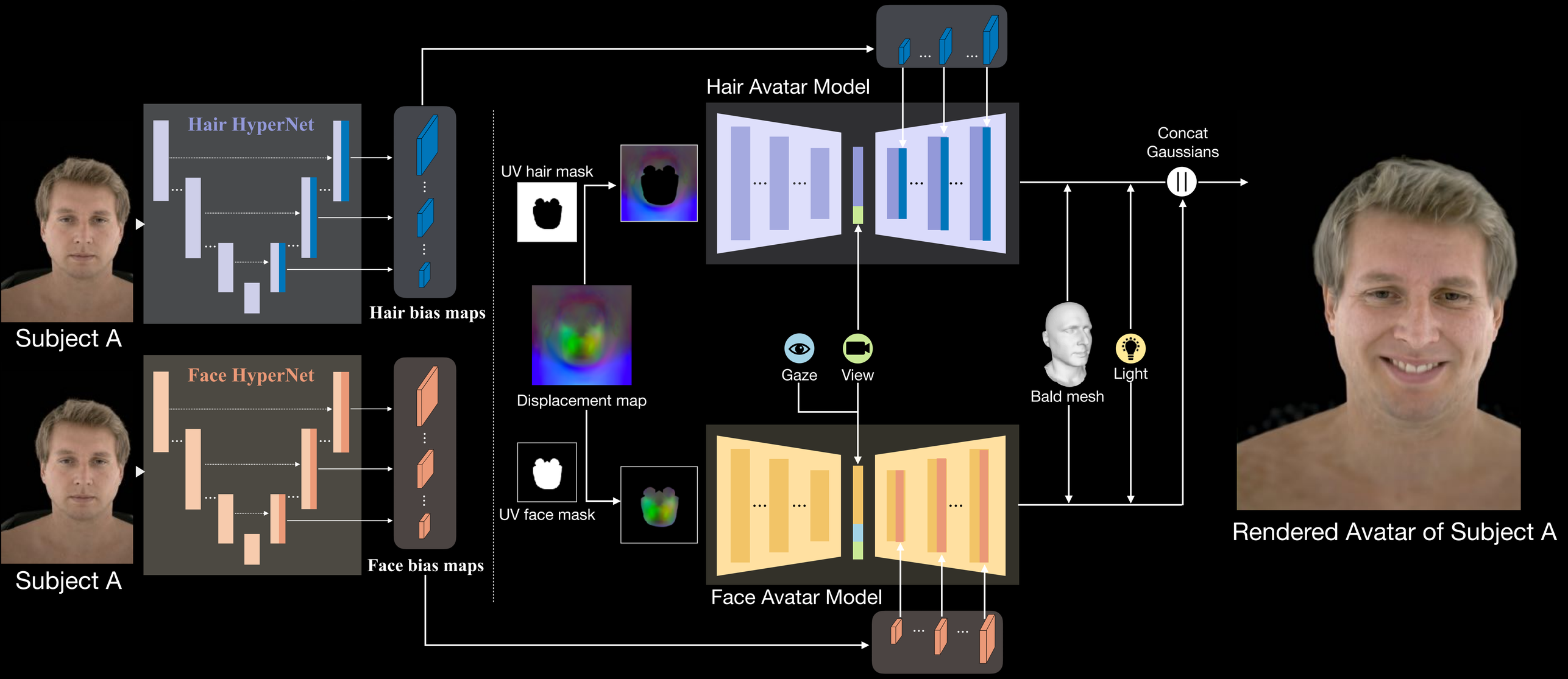
Compositional Universal Avatar Model

Compositional Universal Avatar Model with HyperNets



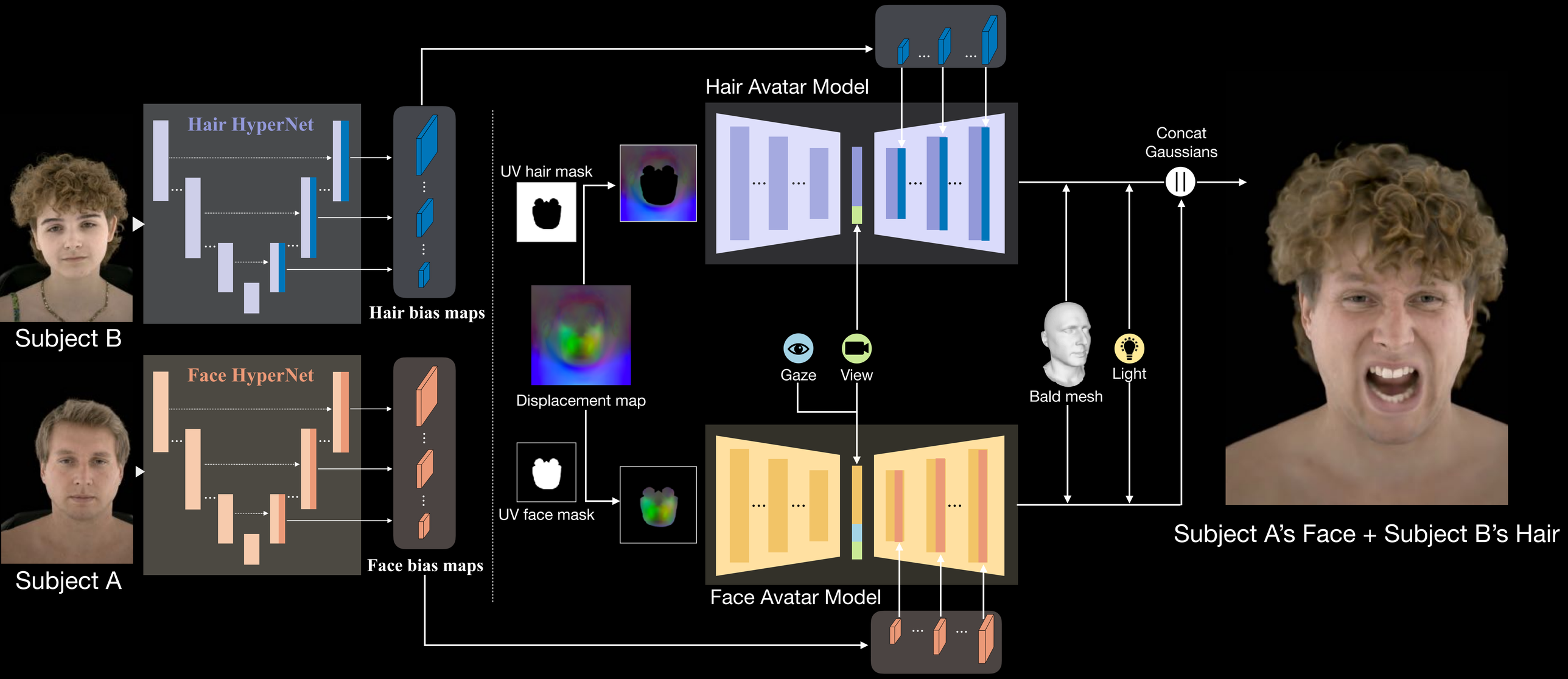
Compositional Universal Avatar Model

Inference: Hairstyle Transfer



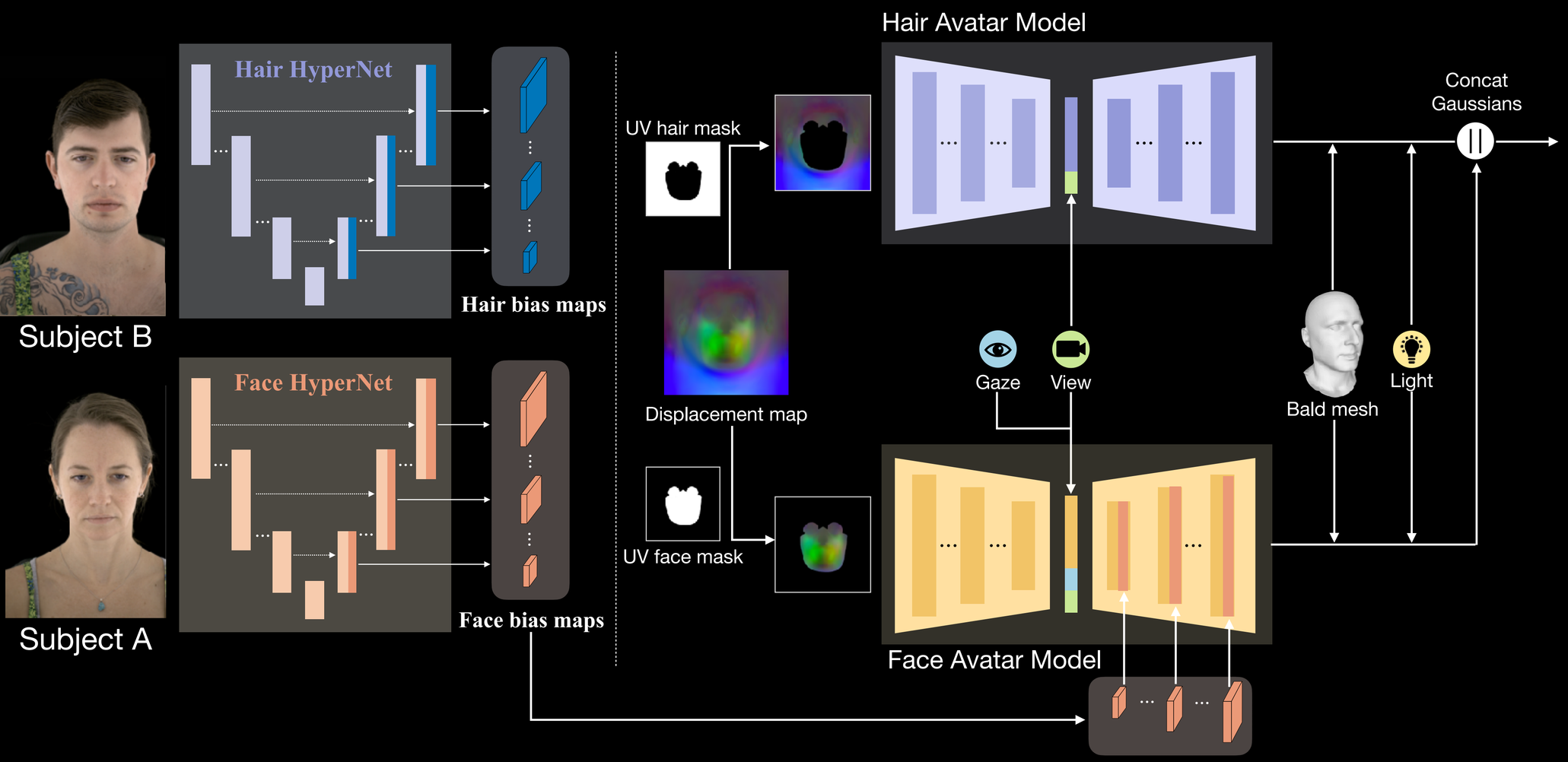
Compositional Universal Avatar Model

Inference: Hairstyle Transfer



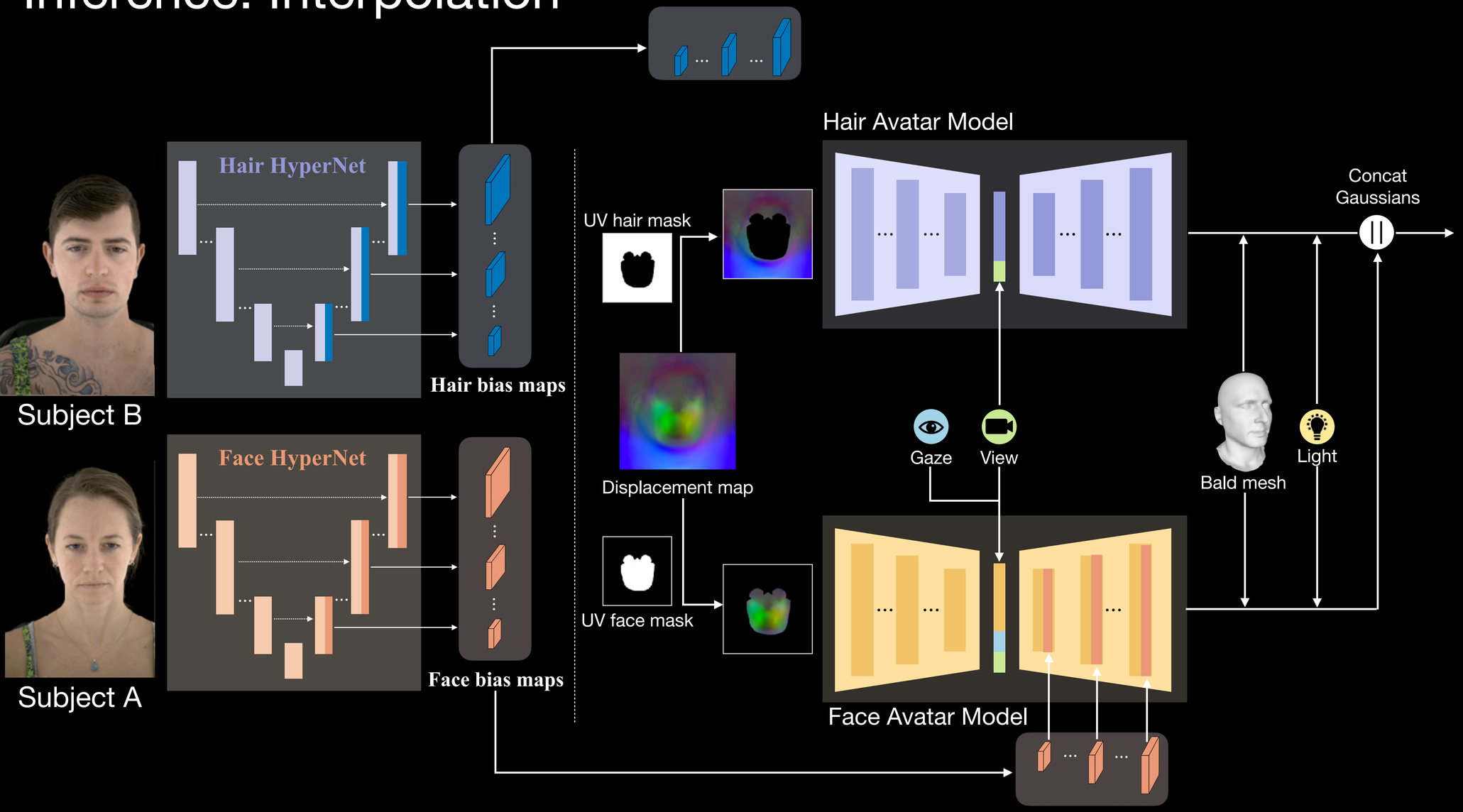
Compositional Universal Avatar Model

Inference: Interpolation



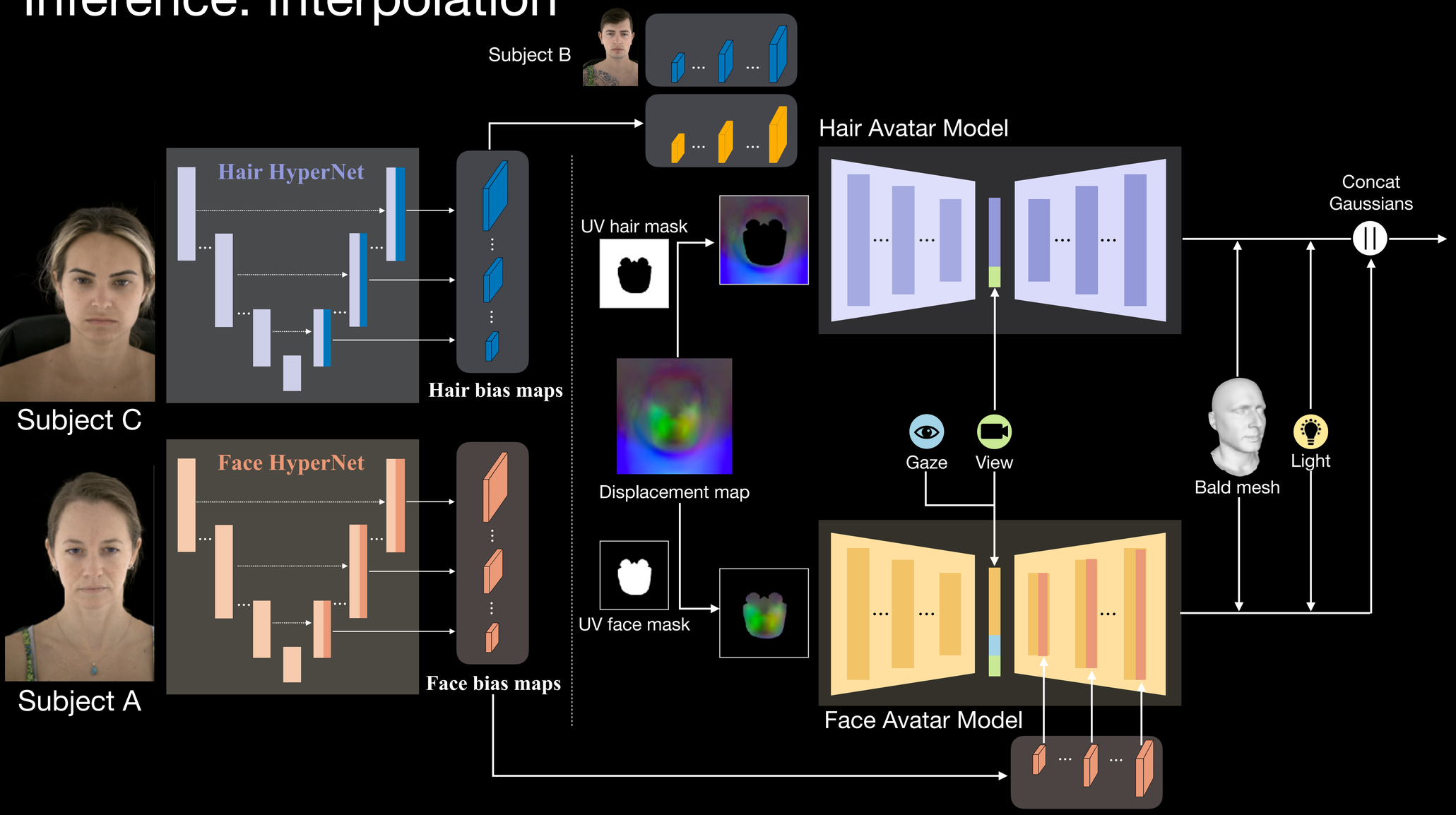
Compositional Universal Avatar Model

Inference: Interpolation



Compositional Universal Avatar Model

Inference: Interpolation



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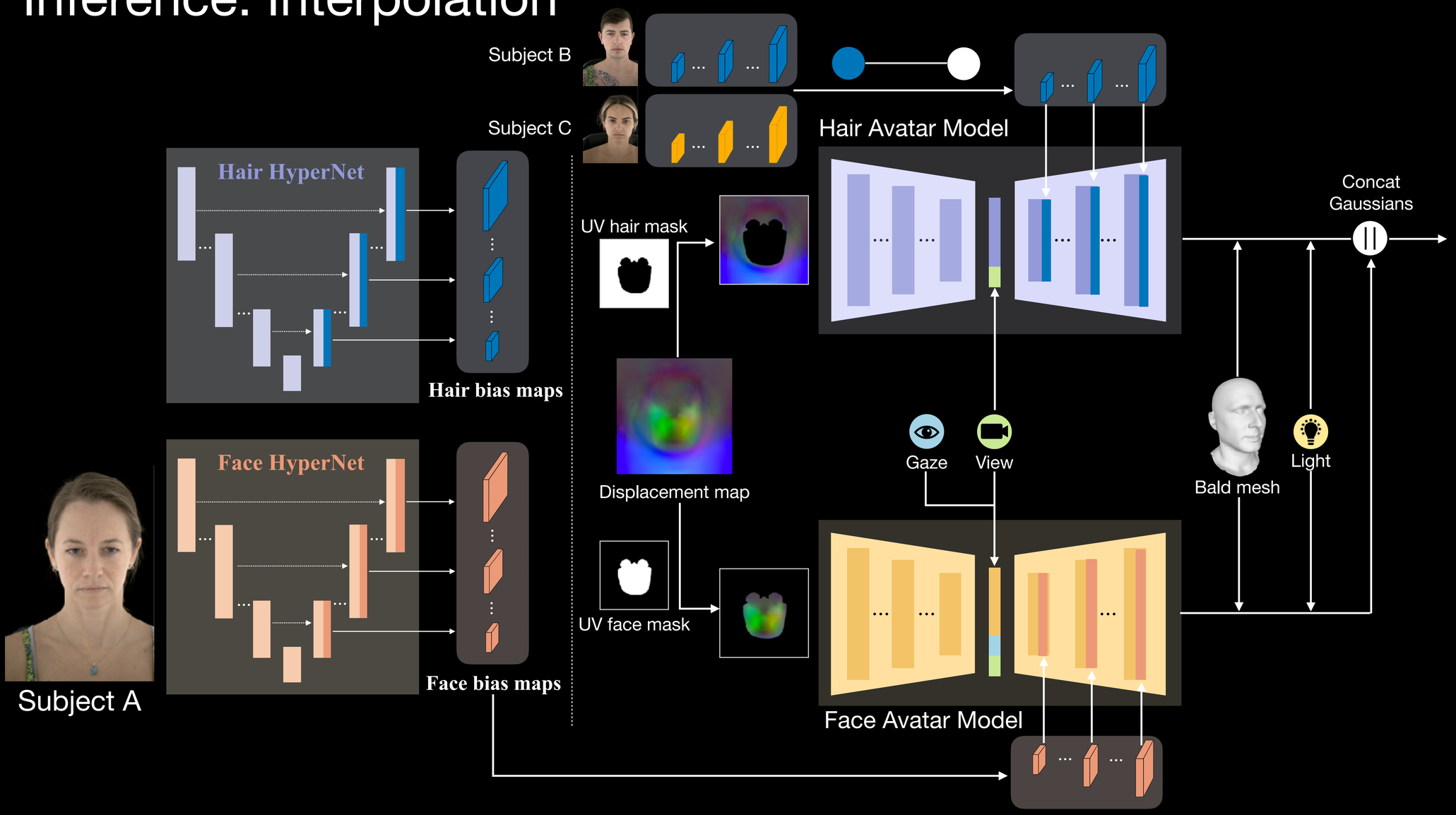
Inference: Interpolation



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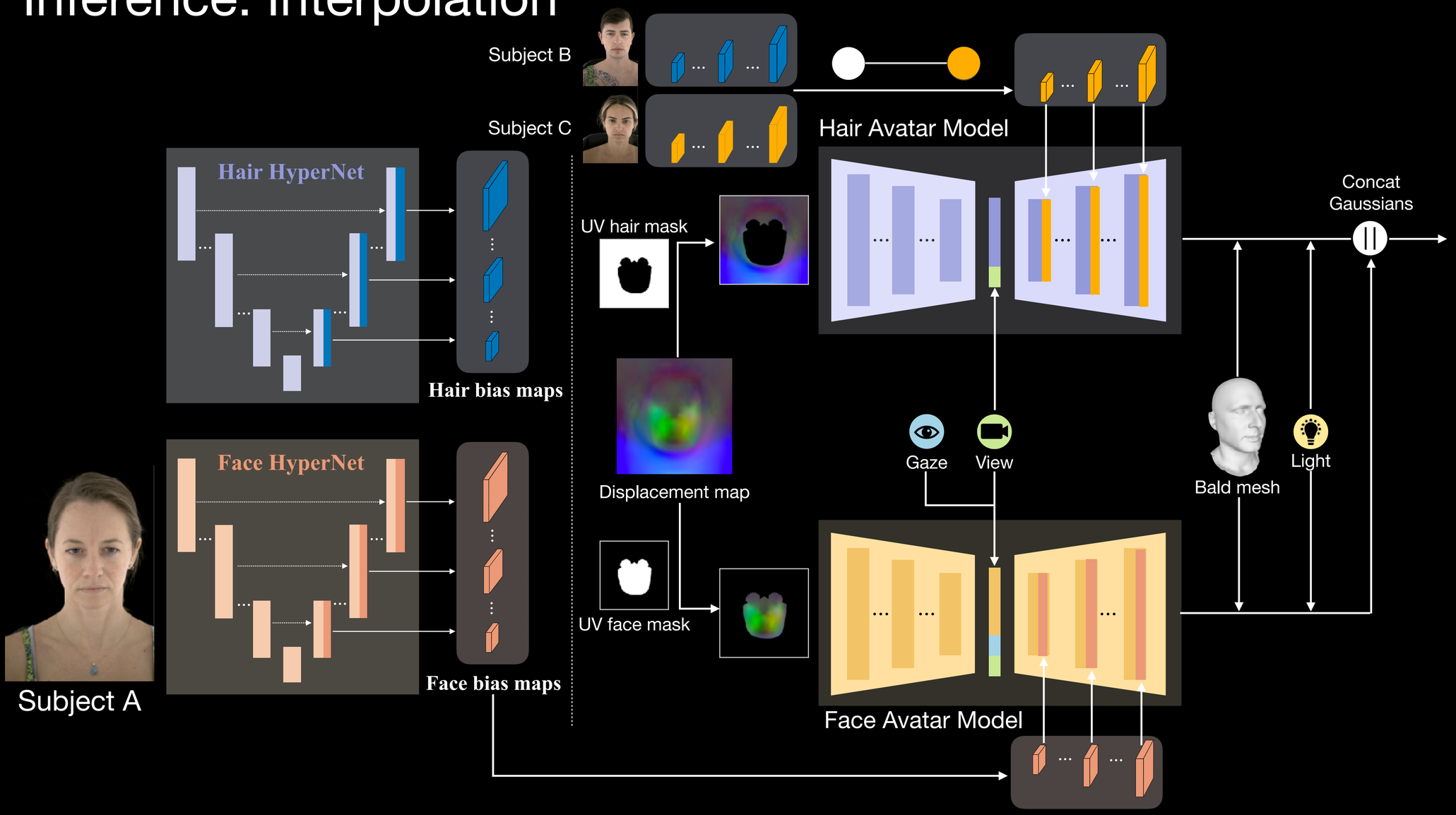

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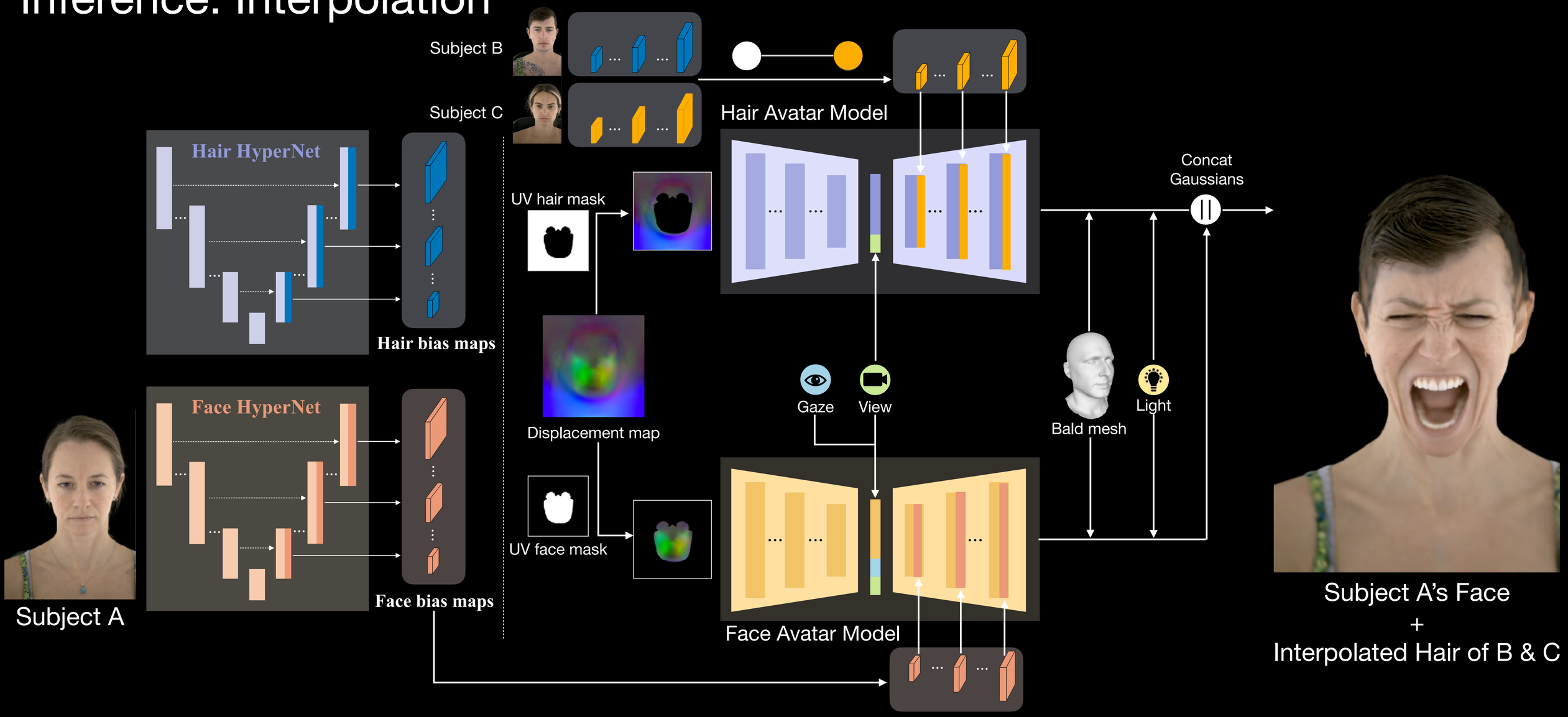


Results

Universal Compositional Avatars

Driving Video | Compositional Avatar | Hair-only | Face-only

Results

Single Hair + Multi Faces

Face Subject A

Face Subject B

Face Subject C

Driving Video (Hair Subject)

Single Hair + Multiple Faces

Comparison

Interpolation

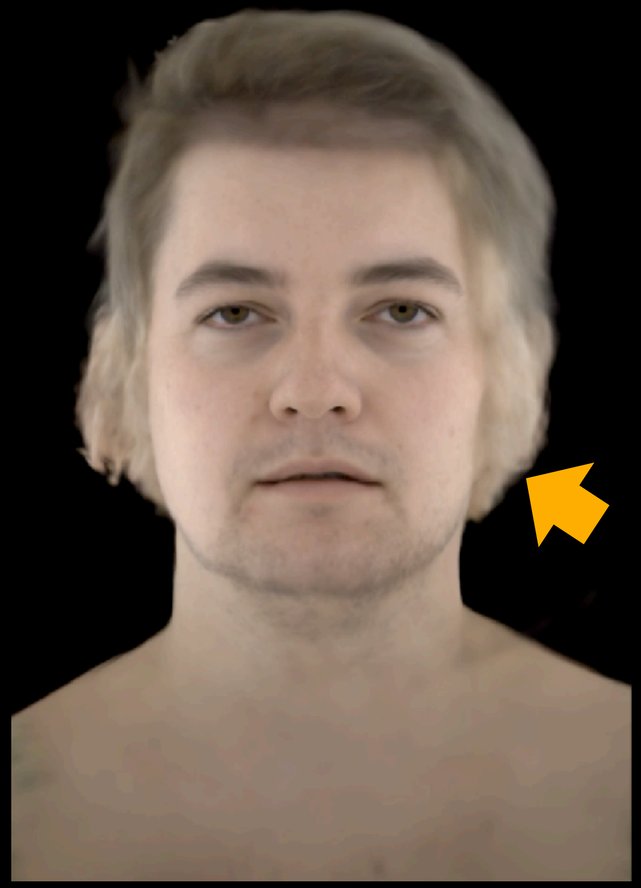
Li et al.

Ours

Li et al., “Universal Relightable Gaussian Codec Avatars.” (Siggraph 2025)

Comparison

Interpolation



Li et al.

Ours

Li et al., “Universal Relightable Gaussian Codec Avatars.” (Siggraph 2025)

Comparison

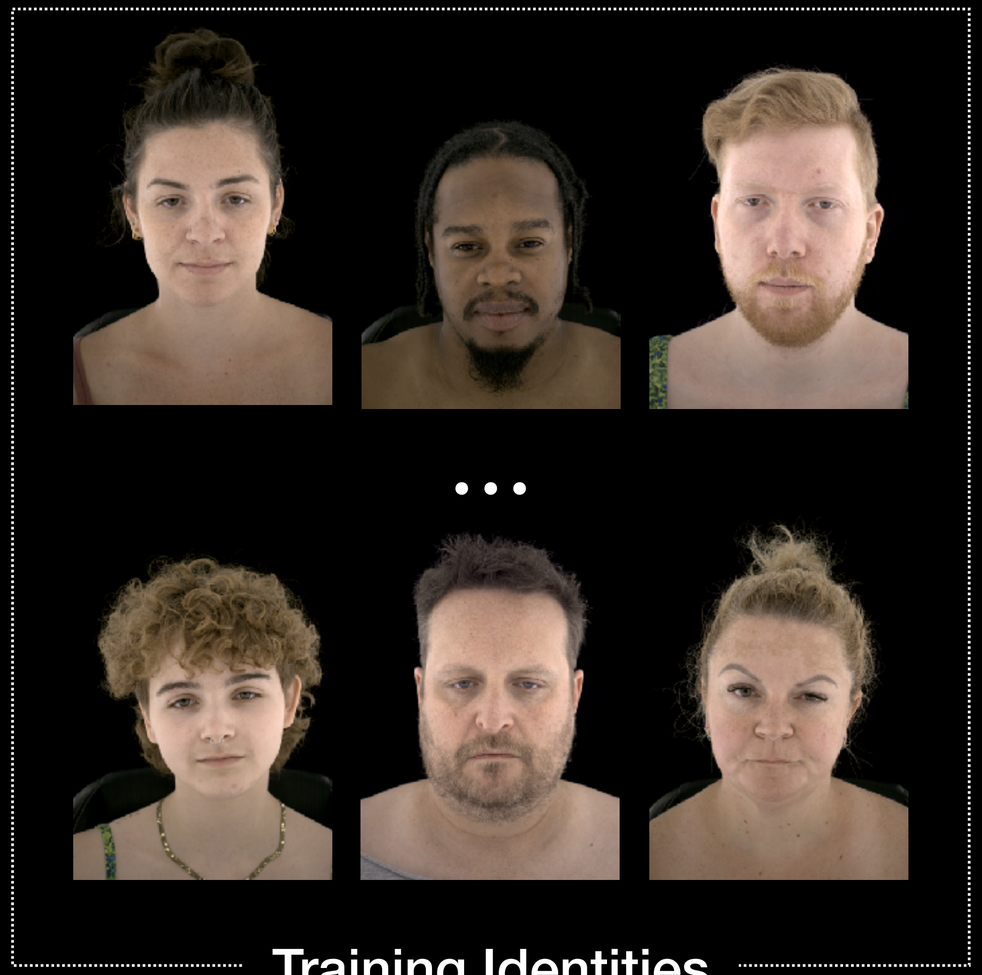
Interpolation

Li et al.

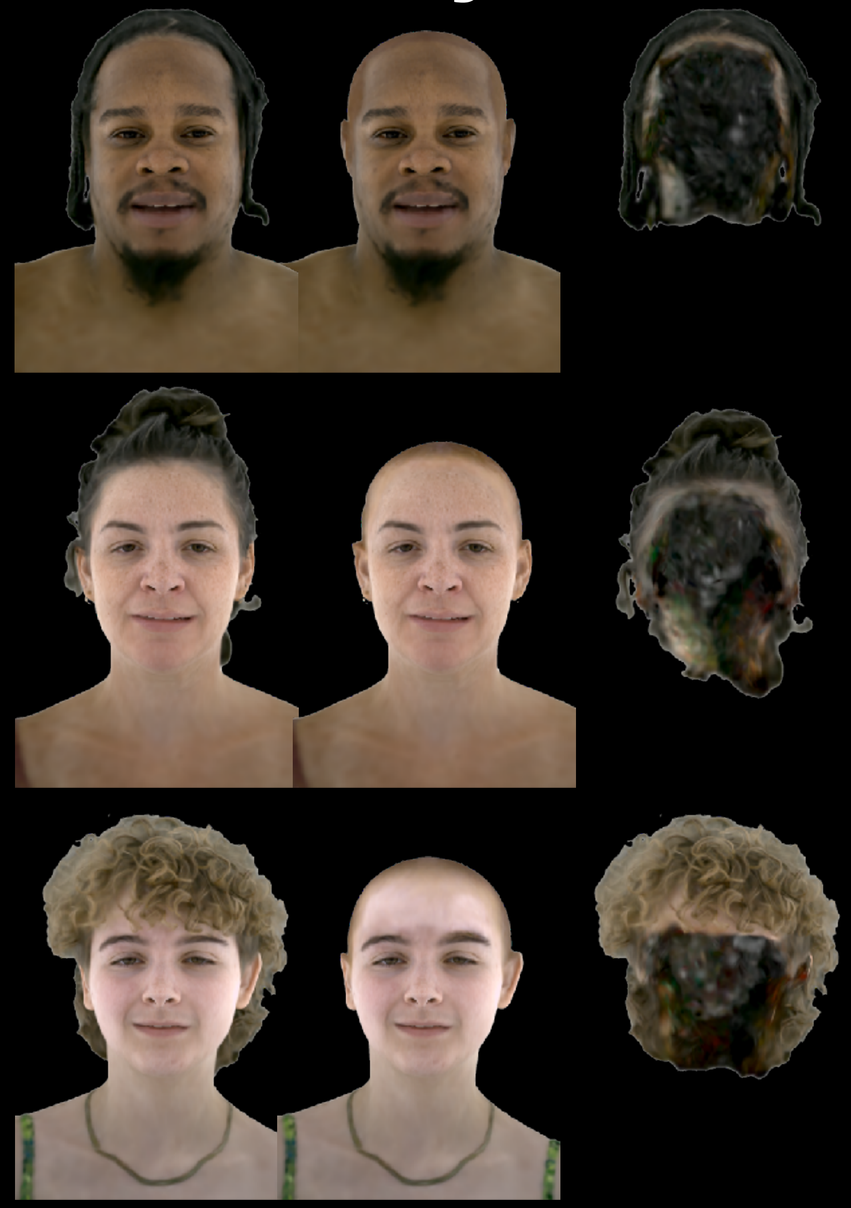
Ours

Li et al., “Universal Relightable Gaussian Codec Avatars.” (Siggraph 2025)

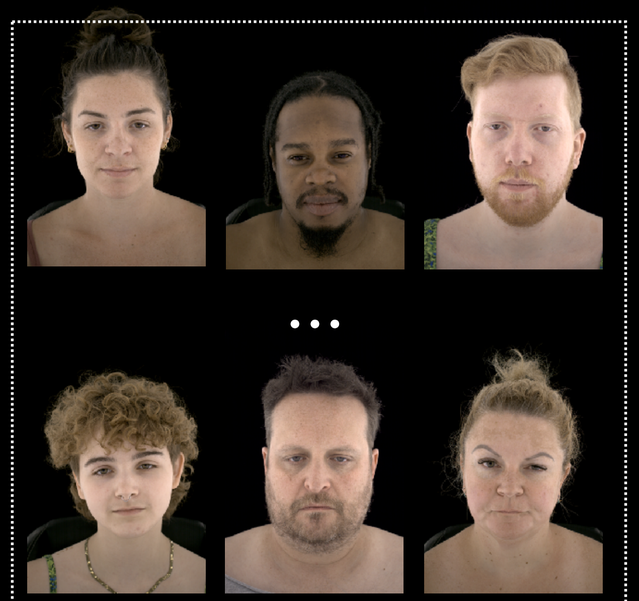
Compositional Avatar for Unseen Identity



HairCUP



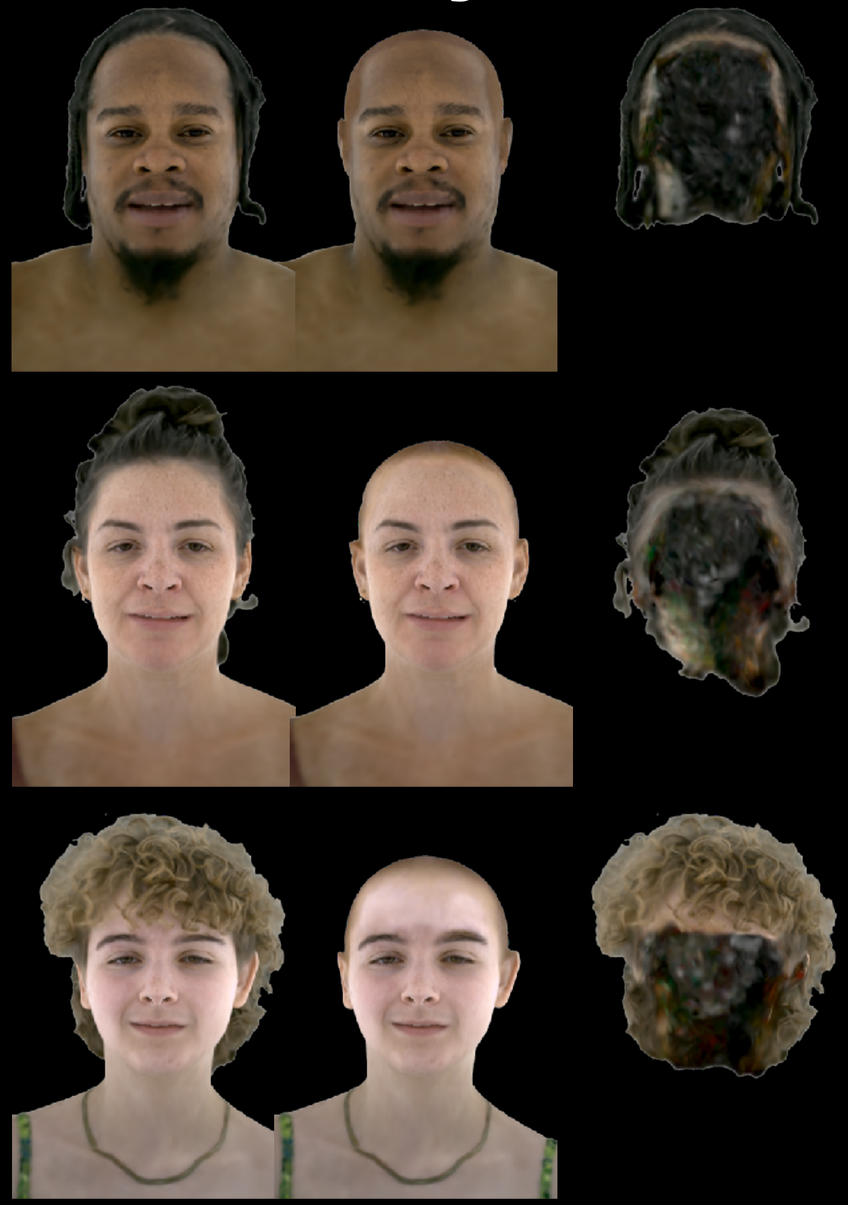
Compositional Avatar for Unseen Identity



Training Identities

Unseen Identity

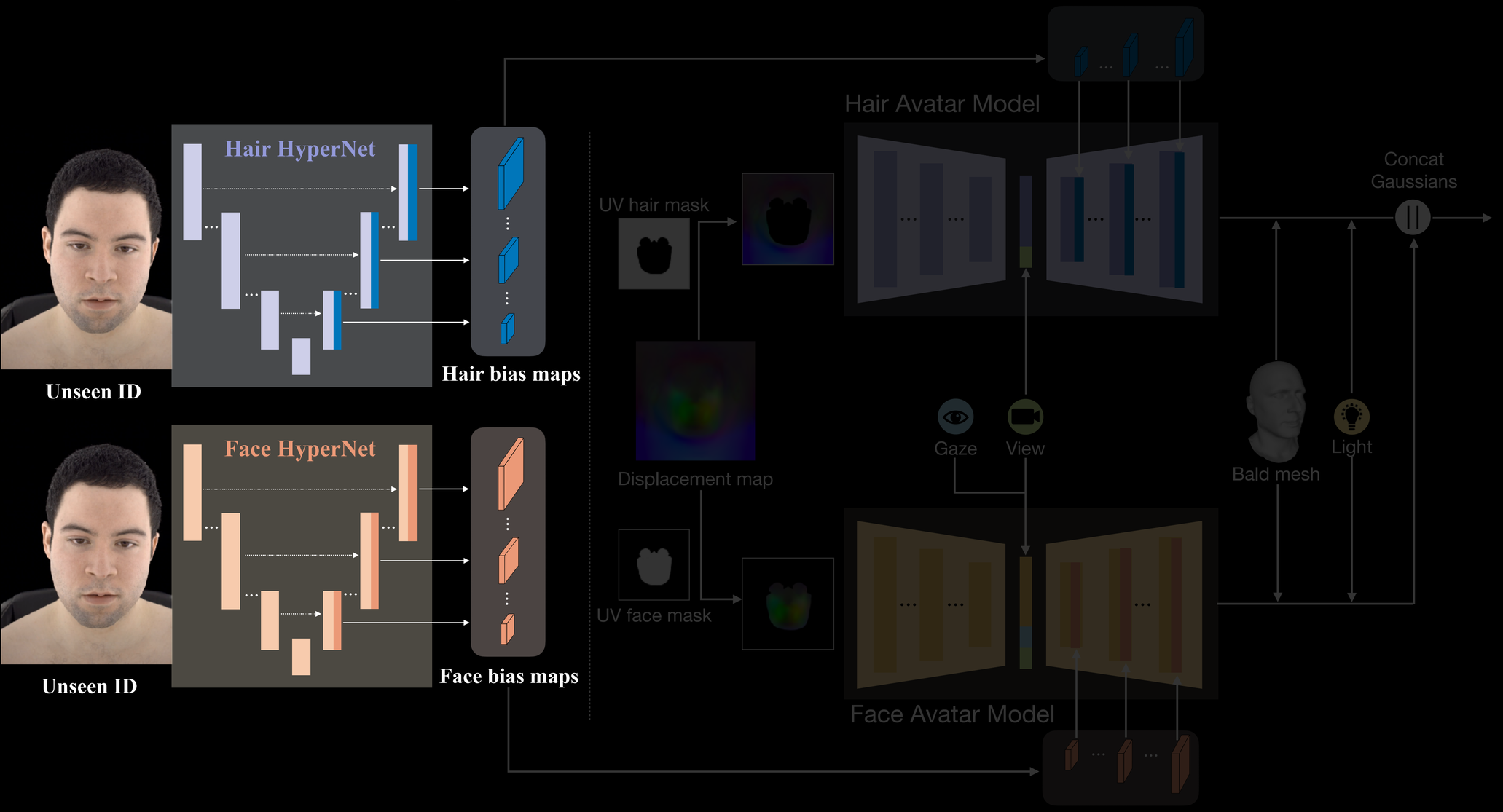
HairCUP



Comp. Avatar Hair-only Face-only

Compositional Avatar for Unseen Identity

Without Finetuning



Compositional Avatar for Unseen Identity

Without Finetuning

Groundtruth | Zero-shot Avatar | Hair-only | Face-only

Compositional Avatar for Unseen Identity

With Finetuning

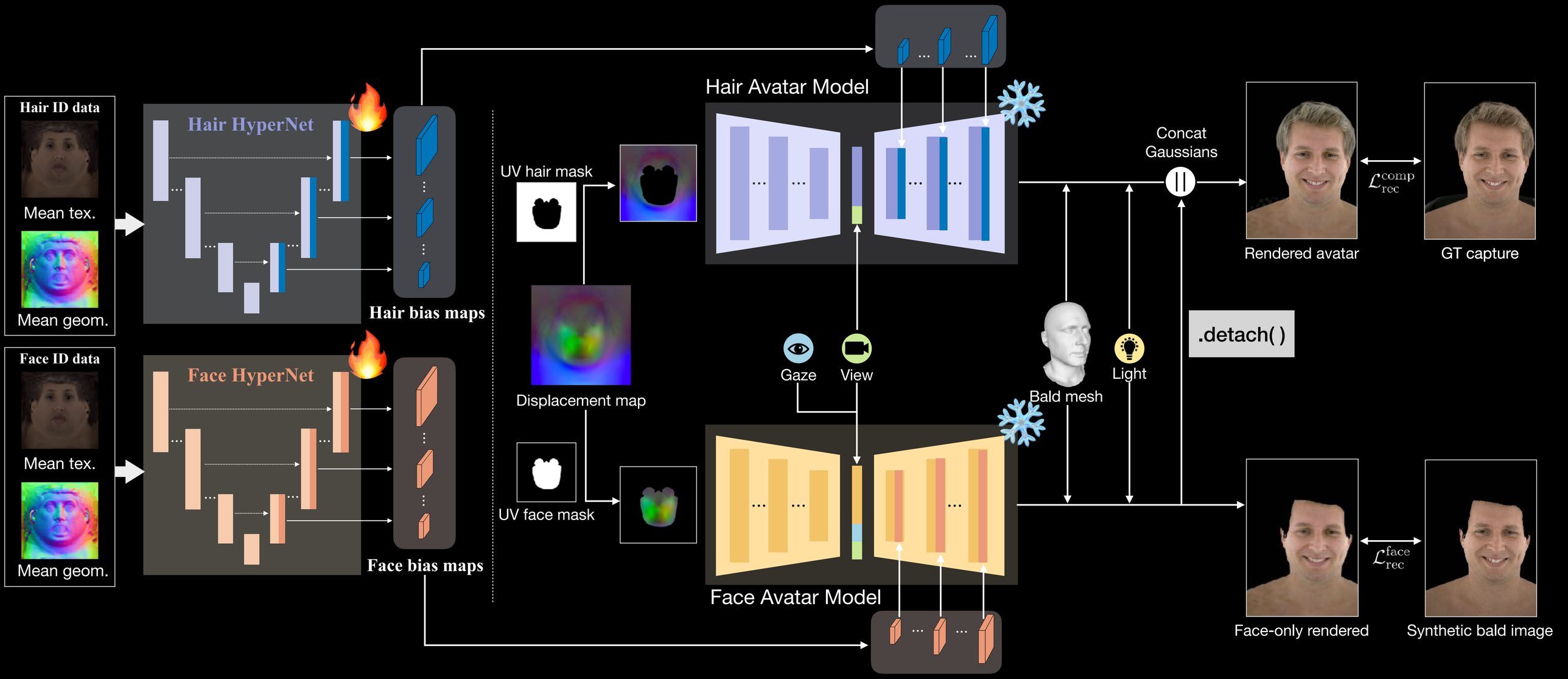
Few-shot Inputs

HairCUP 🔥

Finetuned Compositional Avatar

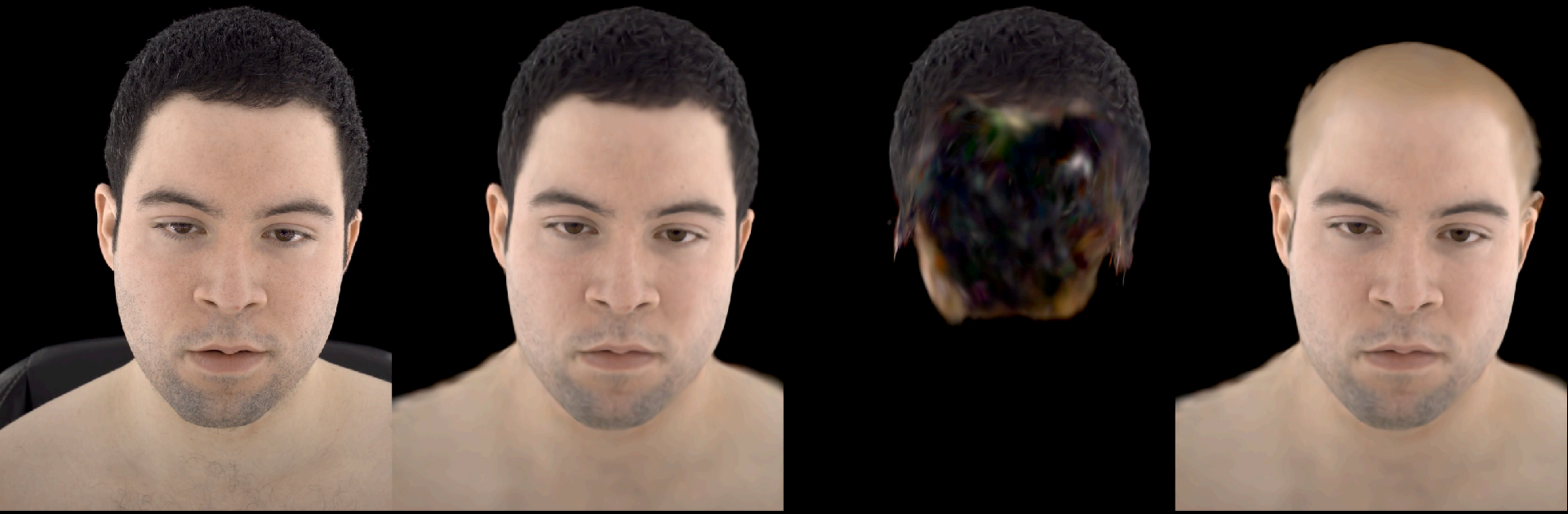
Compositional Avatar for Unseen Identity

Finetuning



Compositional Avatar for Unseen Identity

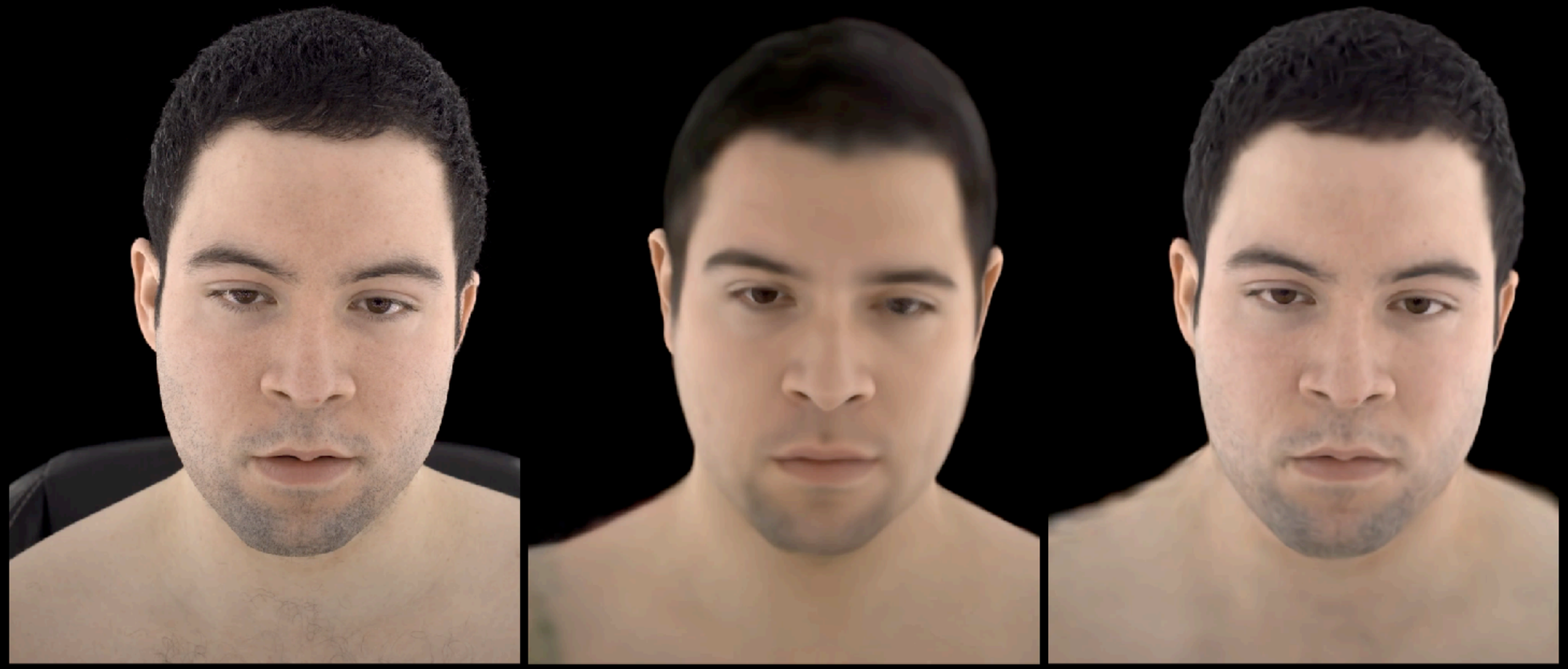
With Finetuning



Groundtruth | Finetuned Avatar | Hair-only Avatar | Face-only Avatar

Compositional Avatar for Unseen Identity

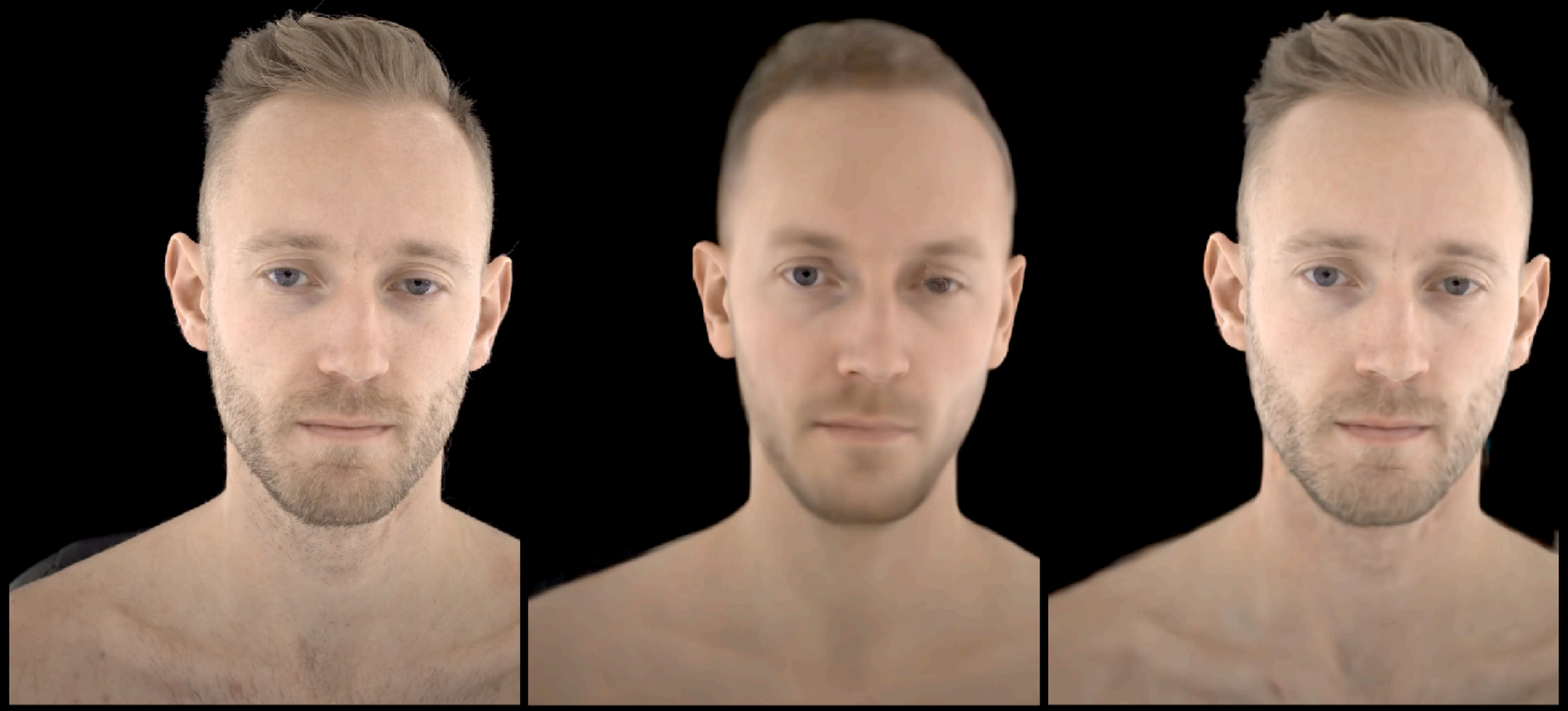
W/o Finetuning vs w/ Finetuning



Groundtruth | Avatar without Finetuning | Avatar with Finetuning

Compositional Avatar for Unseen Identity

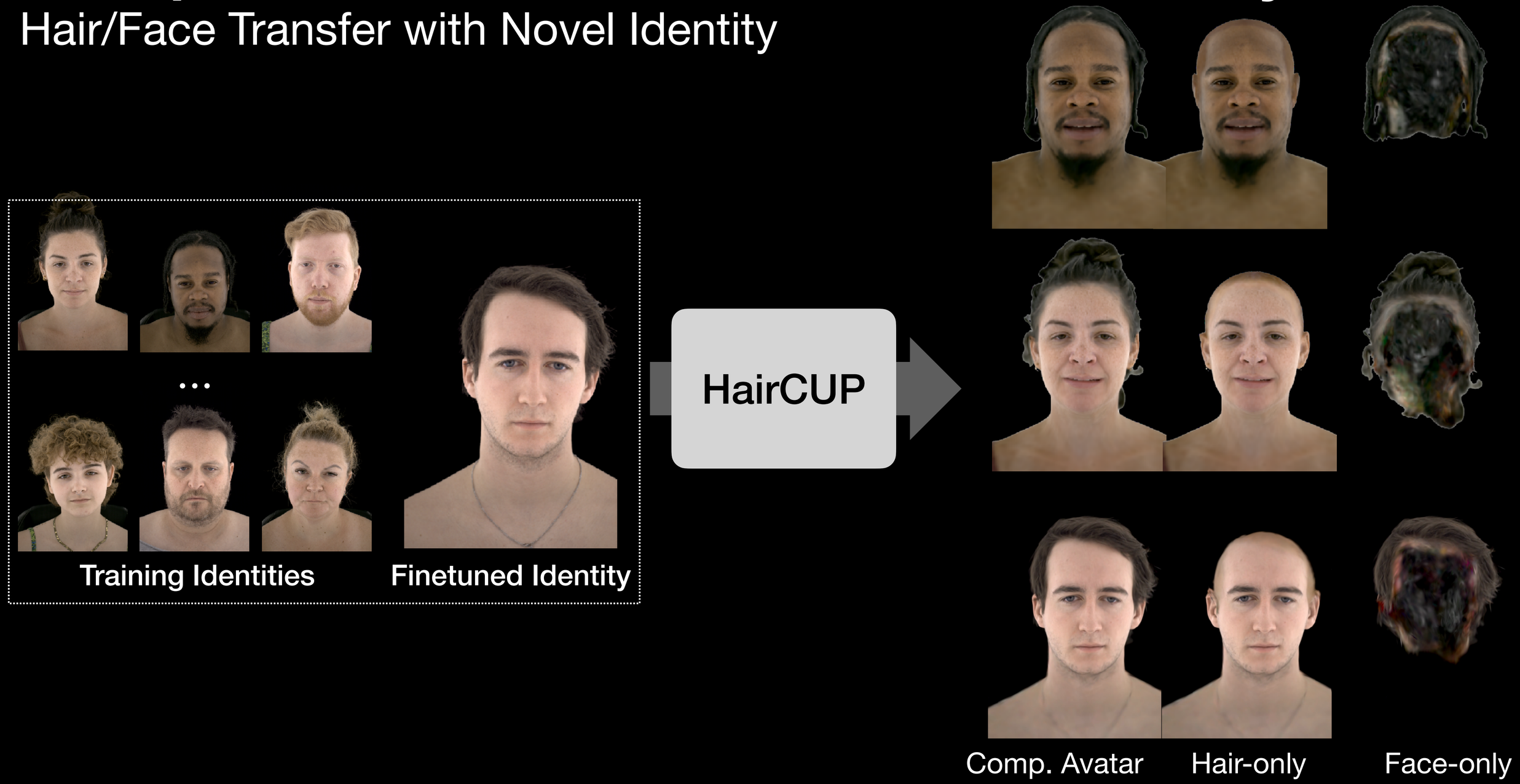
W/o Finetuning vs w/ Finetuning



Groundtruth | Avatar without Finetuning | Avatar with Finetuning

Compositional Avatar for Unseen Identity

Hair/Face Transfer with Novel Identity



Compositional Avatar for Unseen Identity

Hair/Face Transfer with Novel Identity

Face subject
(Finetuned)

+

Hair subject
(Training)

→

Compositional Avatar for Unseen Identity

Hair/Face Transfer with Novel Identity

Face subject
(Training)

+

Hair subject
(Finetuned)

→

HairCUP

Hair Compositional Universal Prior for 3D Gaussian Avatars

📍Find our poster!
Exhibit Hall I #1138
Wed, Oct 22
11:15 am - 1:15 pm