

# AVATAR DIGITIZATION FROM A SINGLE IMAGE FOR REAL-TIME RENDERING

Cosimo

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Carrie Sun<sup>1</sup> Yen-Chun Chen<sup>1</sup> Hao Li<sup>1,2,3</sup>



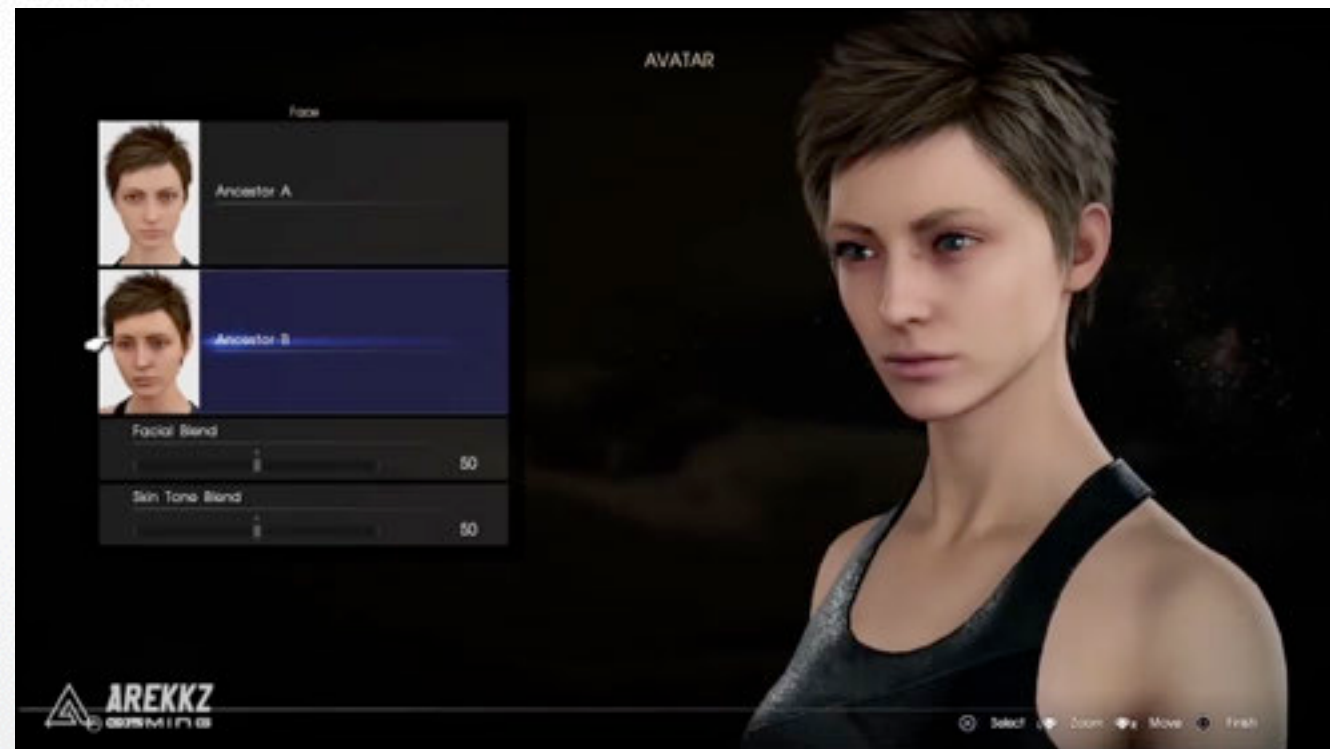
# Introduction



Xbox One



Sims 4

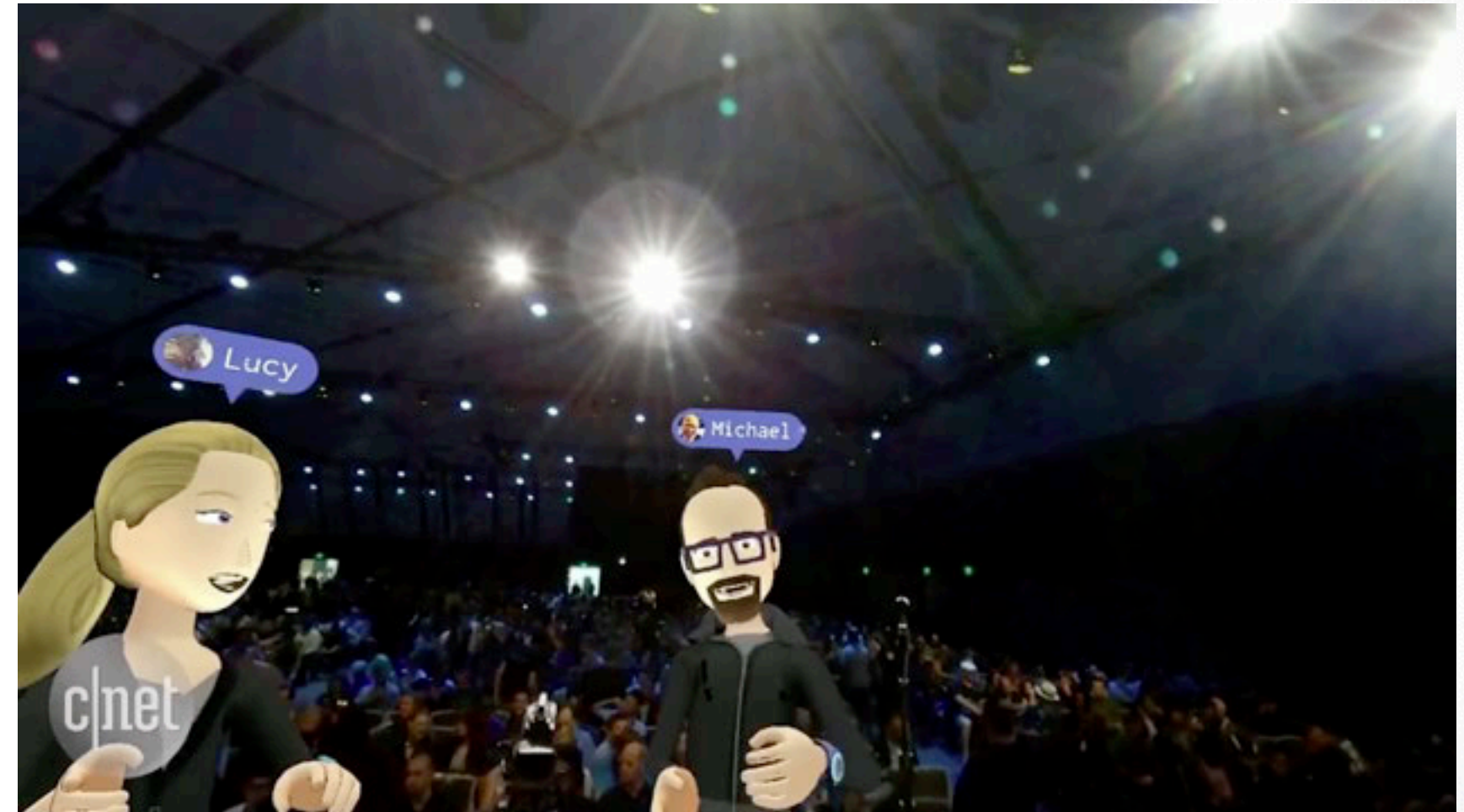


Final Fantasy 14



NBA 2K7

# Introduction



Oculus

# Introduction



input single image

# Introduction



input single image



digital avatar

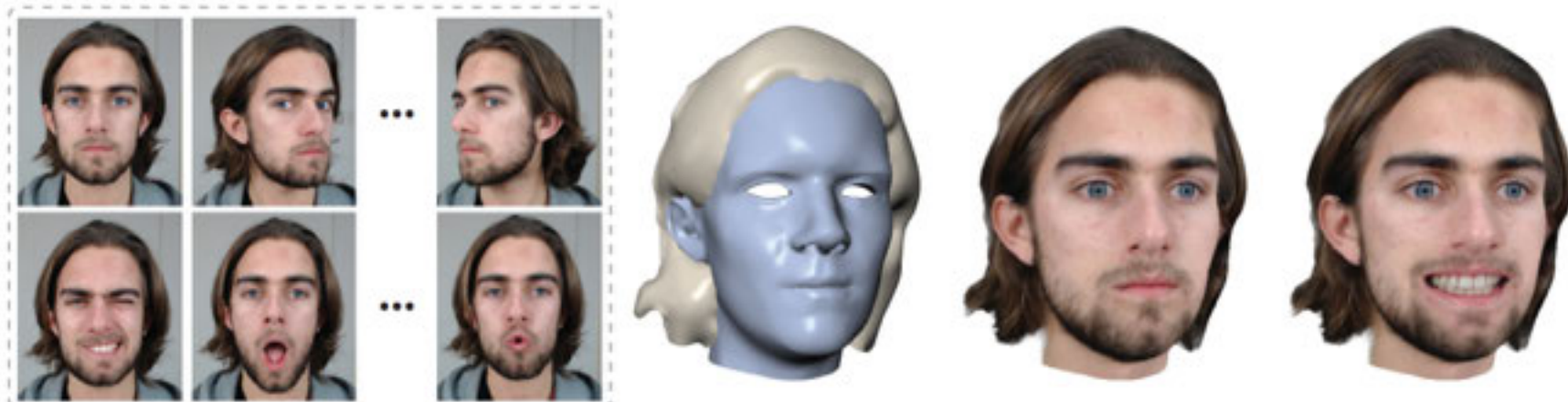
# Related Works - Facial Modeling and Capture



*[Beeler et al. 2010]*



*[Bradley et al. 2010]*

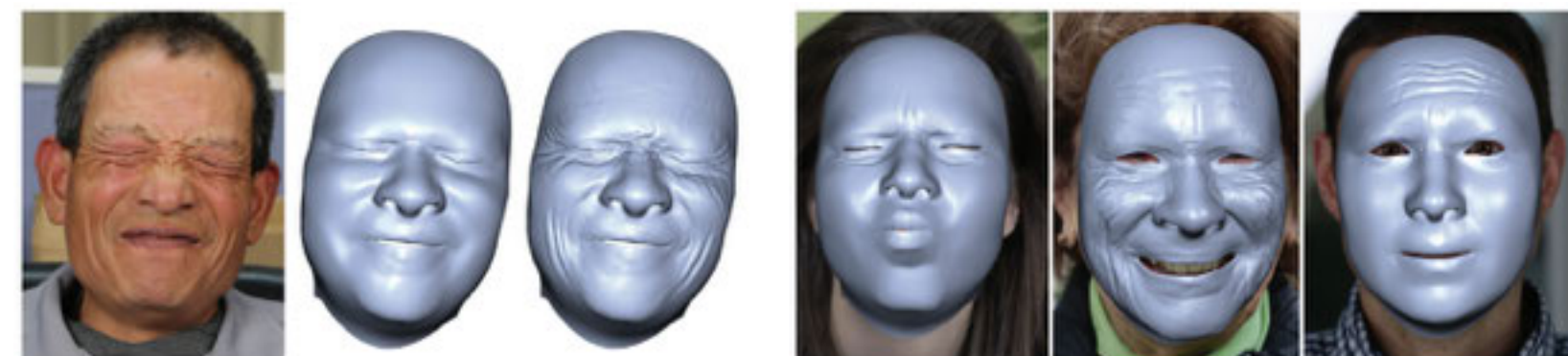


*[Cao et al. 2016]*

# Related Works - Facial Modeling and Capture



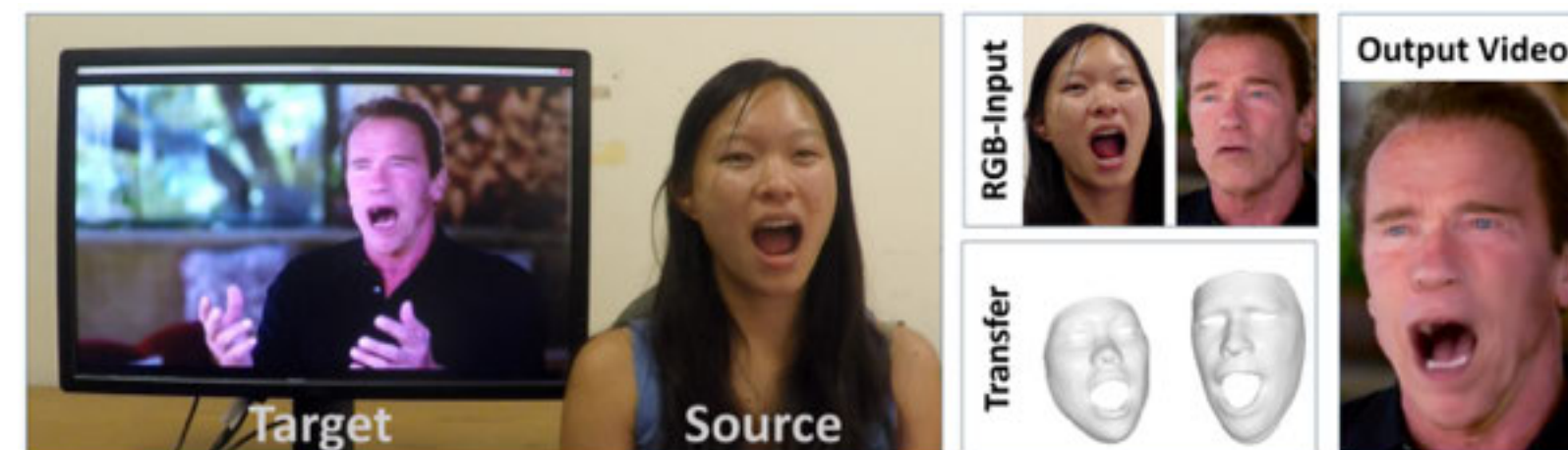
[Beeler et al. 2010]



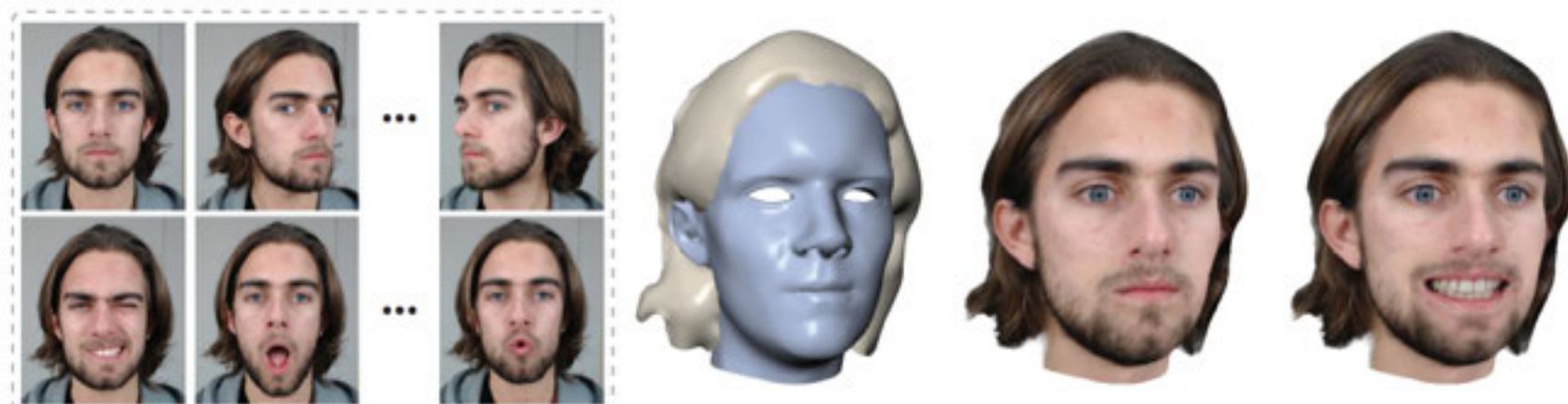
[Cao et al. 2015]



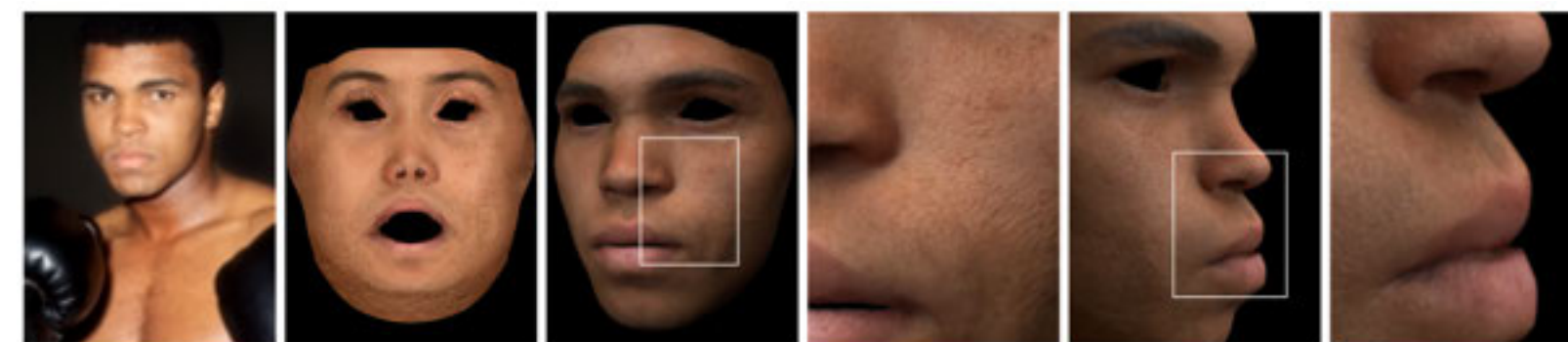
[Bradley et al. 2010]



[Thies et al. 2016]



[Cao et al. 2016]



[Saito et al. 2017]

# Related Works - Hair Modeling and Capture



*[Paris et al. 2008]*



*[Luo et al. 2013]*



*[Hu et al. 2014]*



# Related Works - Hair Modeling and Capture



[Paris et al. 2008]



[Hu et al. 2015]



[Luo et al. 2013]



[Chai et al. 2016]



[Hu et al. 2014]

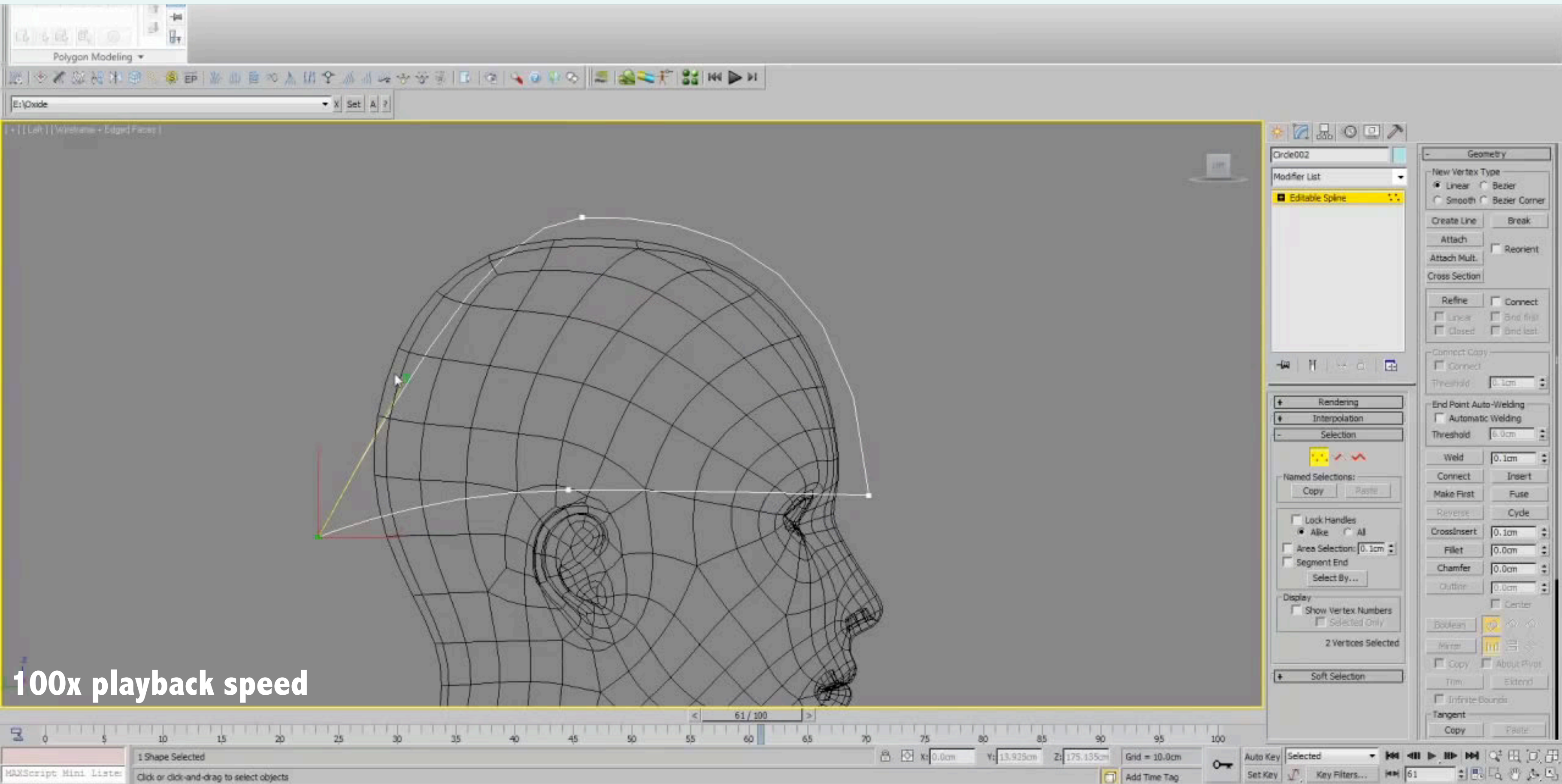


[Zhang et al. 2017]

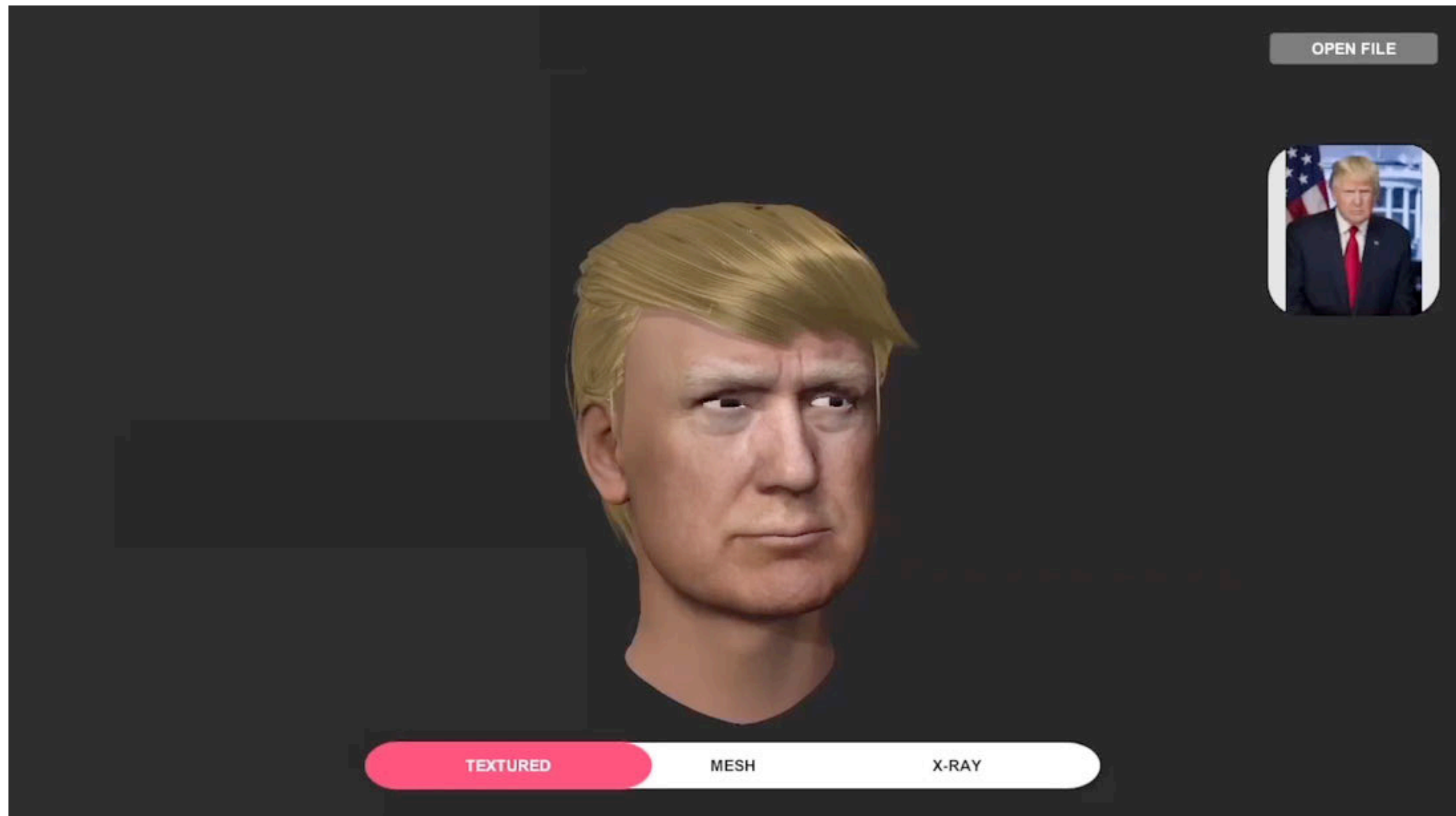
# Related Works - Hair Modeling and Capture



# Introduction



# Introduction



# Overview



*input image*

# Overview



*input image*



*faces and hair  
segmentation*

# Overview



*input image*



*face modeling*



*faces and hair  
segmentation*

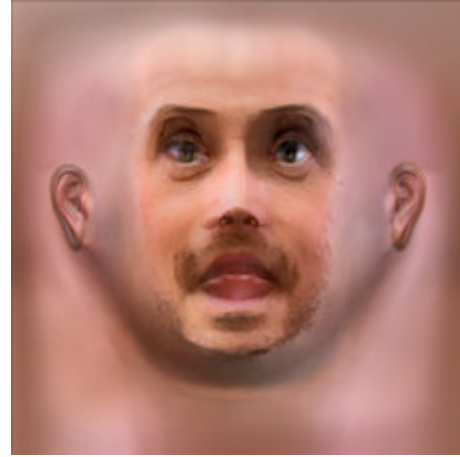
# Overview



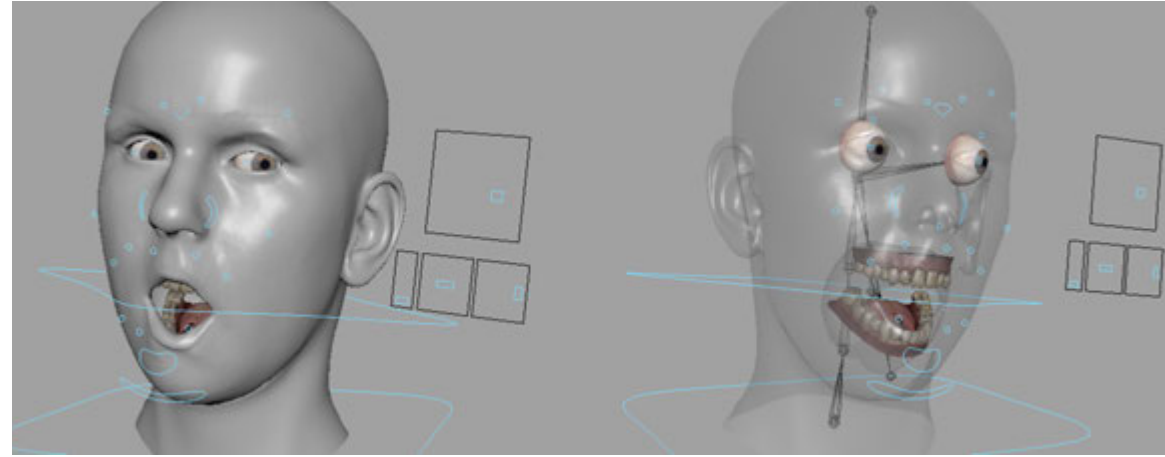
*input image*



*face modeling*



*face texture reconstruction*



*facial rigging (blendshapes, joint-based, secondary components)*



*faces and hair segmentation*



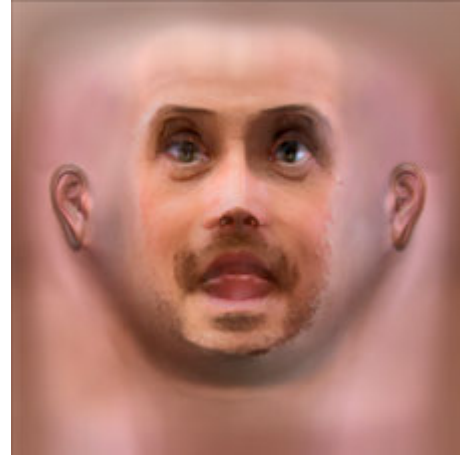
# Overview



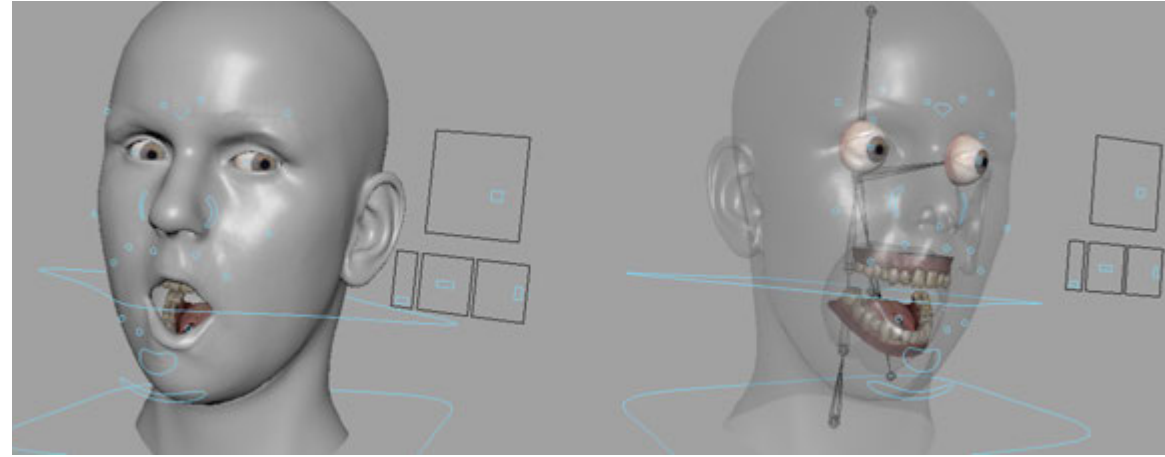
*input image*



*face modeling*



*face texture reconstruction*



*facial rigging (blendshapes, joint-based, secondary components)*



*faces and hair segmentation*



*hairstyle digitization*

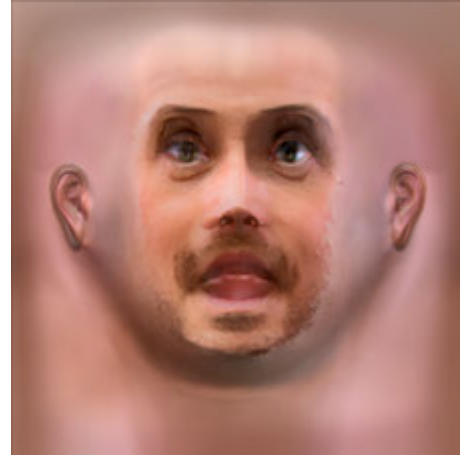
# Overview



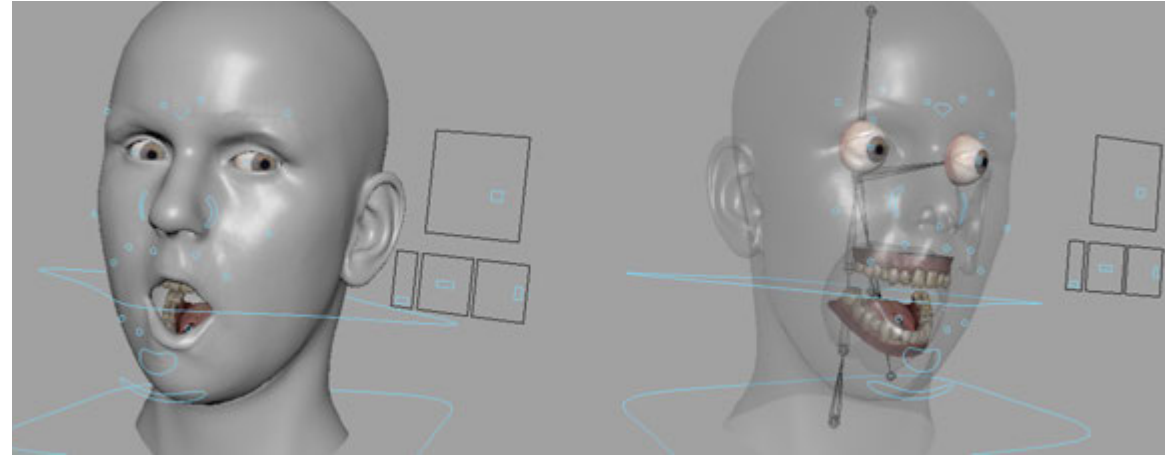
*input image*



*face modeling*



*face texture reconstruction*



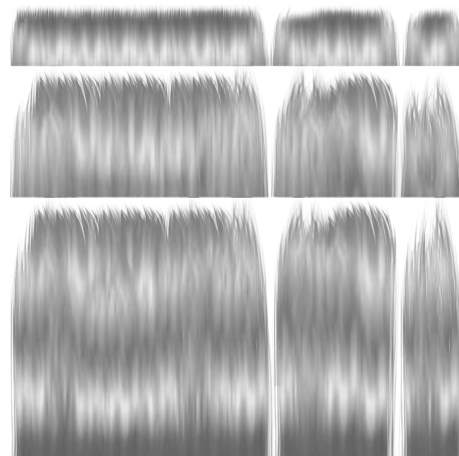
*facial rigging (blendshapes, joint-based, secondary components)*



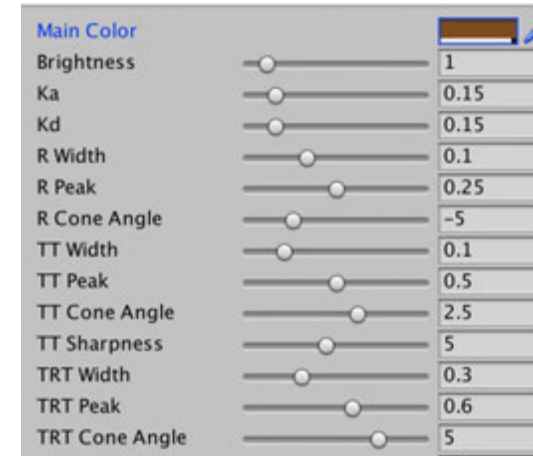
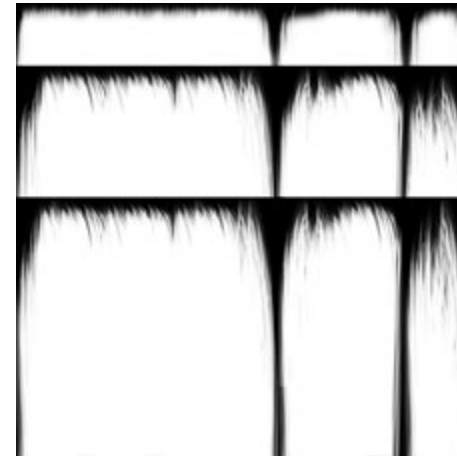
*faces and hair segmentation*



*hairstyle digitization*



*hair appearance matching (shader, texture, alpha mask, bump map, color)*



# Overview



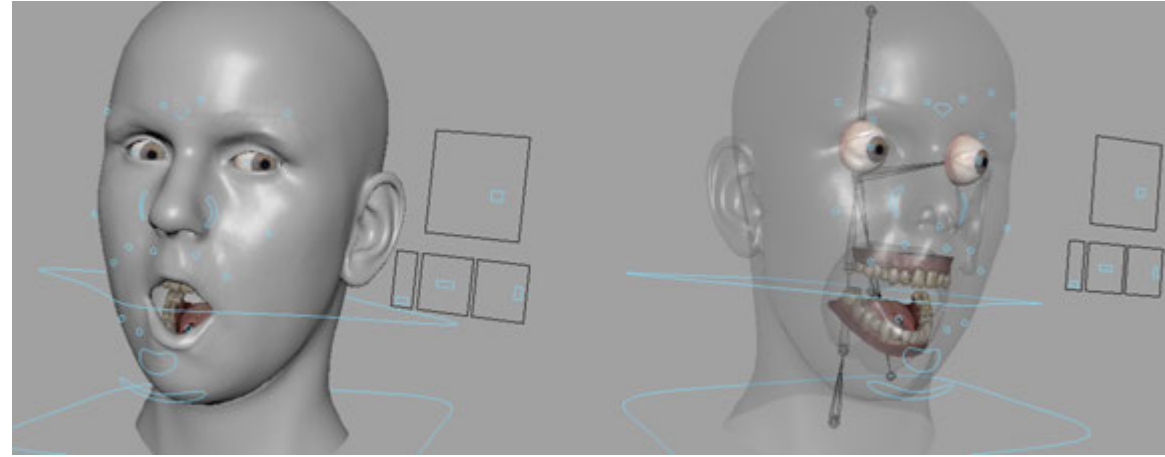
*input image*



*face modeling*



*face texture reconstruction*



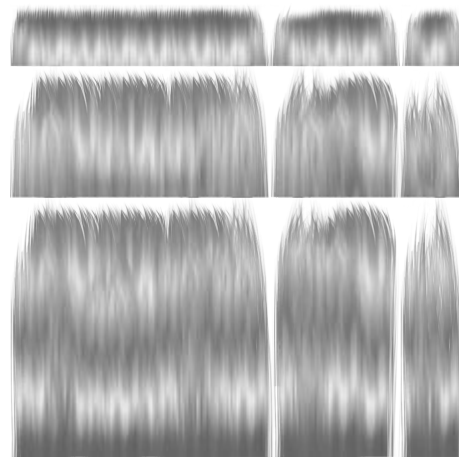
*facial rigging (blendshapes, joint-based, secondary components)*



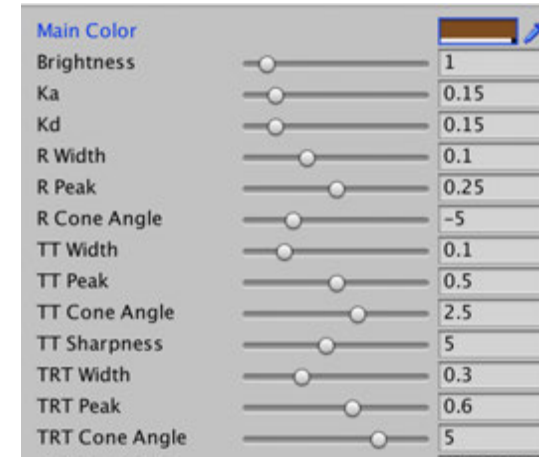
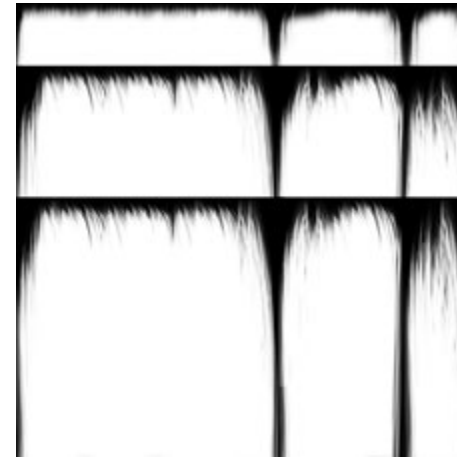
*faces and hair segmentation*



*hairstyle digitization*



*hair appearance matching (shader, texture, alpha mask, bump map, color)*



*real-time 3D avatar rendering*

# Image Pre-Processing



input image

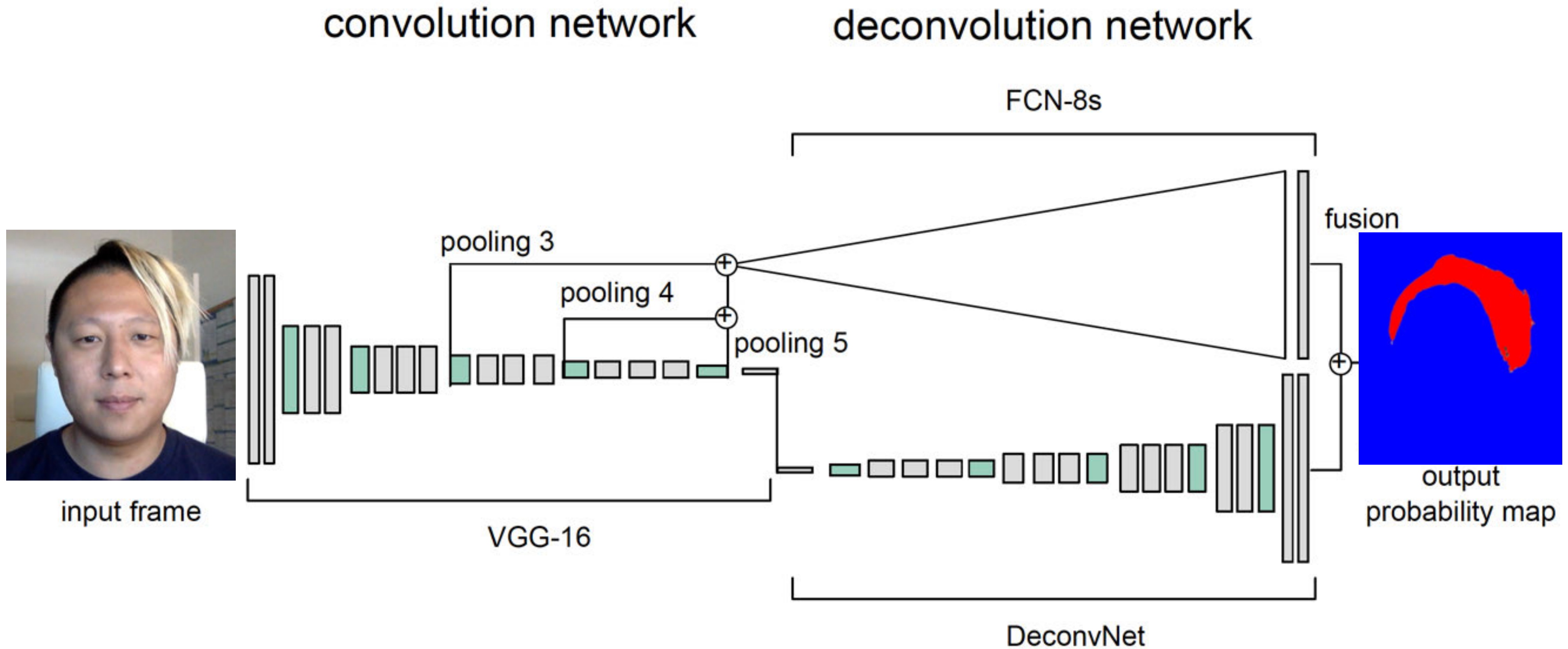


face region



hair region

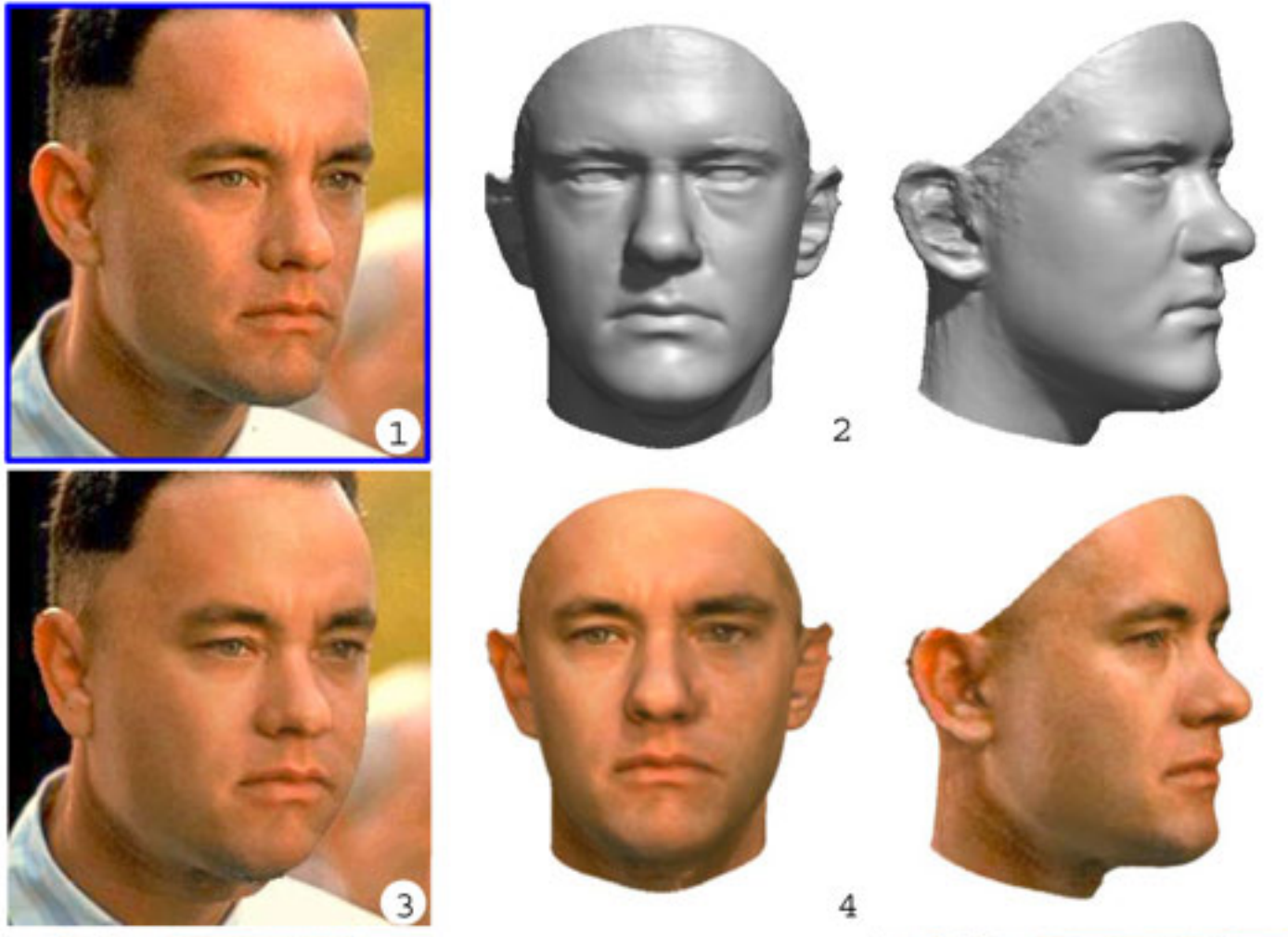
# Image Pre-Processing



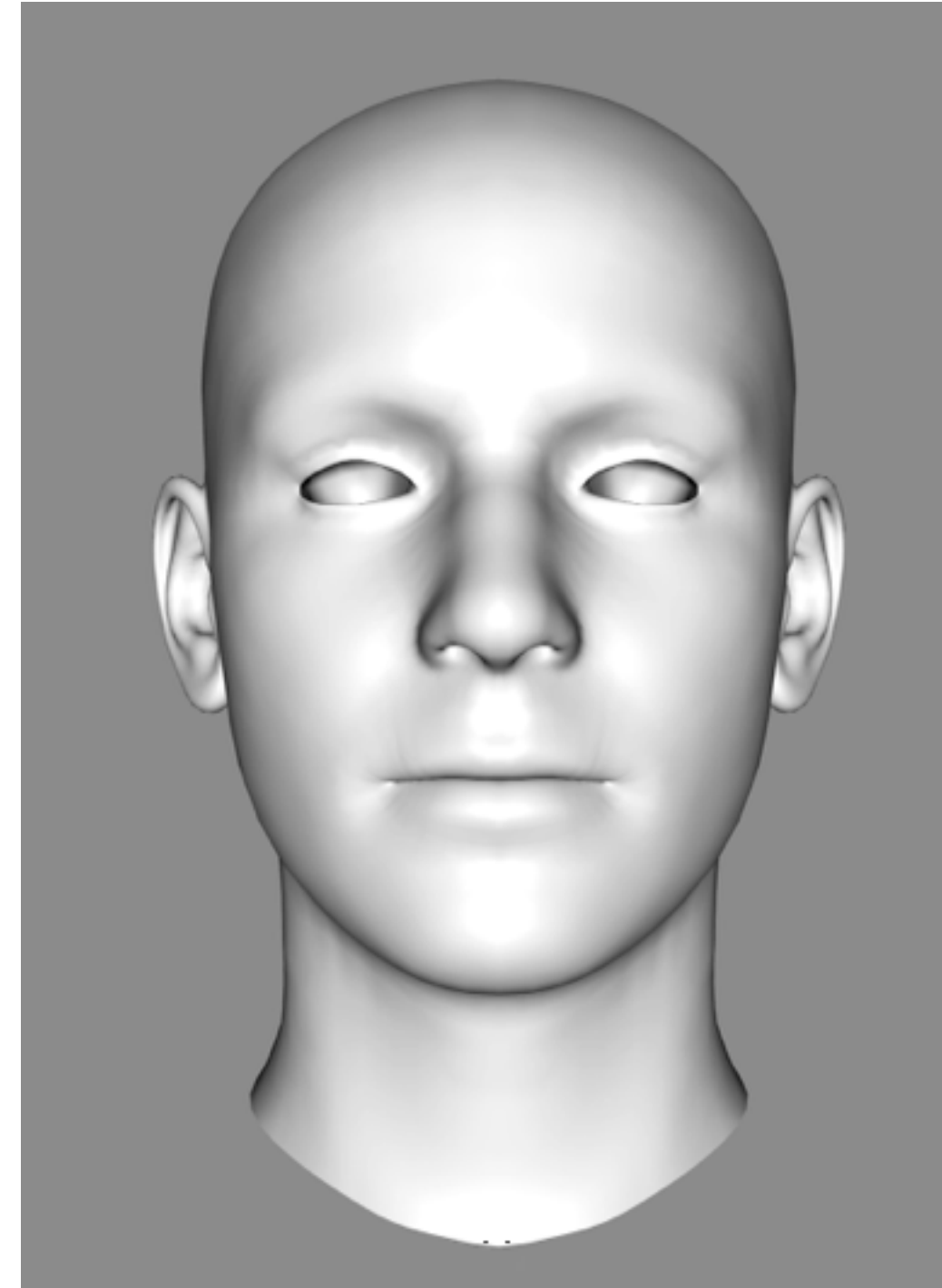
# Face Digitization

# 3D Face Digitization

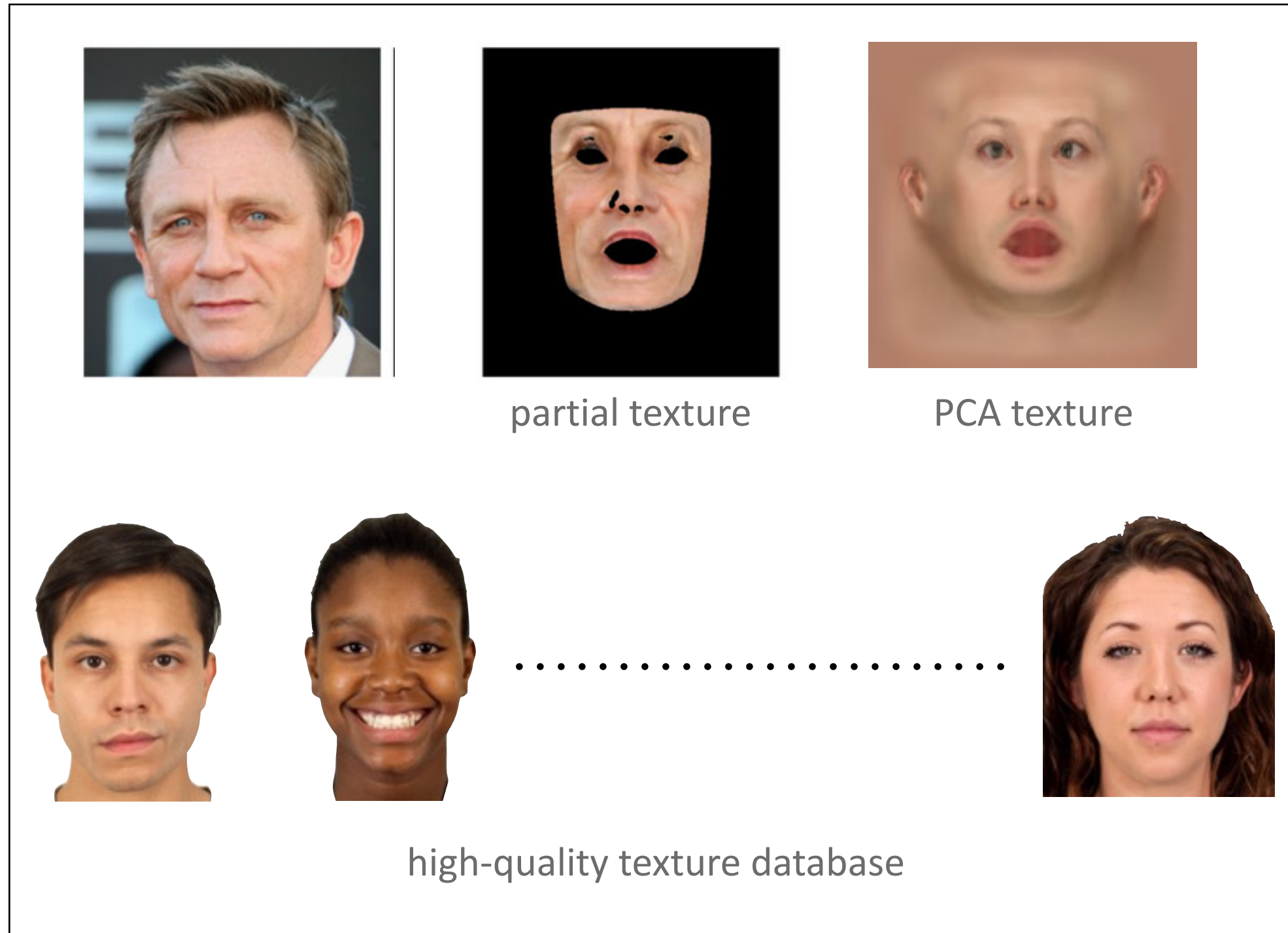
Analysis-by-synthesis 3D head modeling [Blanz and Vetter 1999; Thies et al. 2016]



Morphable Model [Blanz and Vetter 1998]



# Appearance Modeling Pipeline





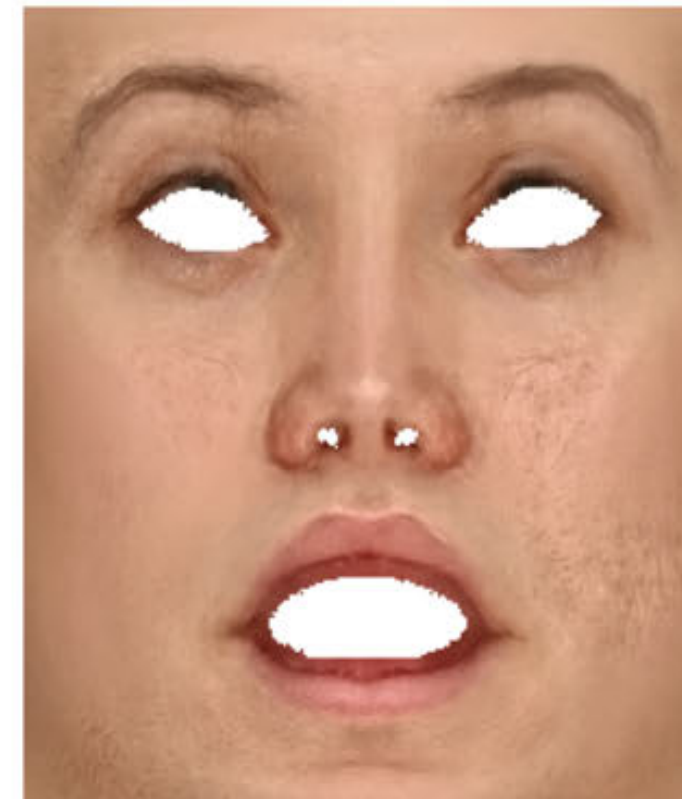
# Visibility Constraints



input image



w/o visibility constraints



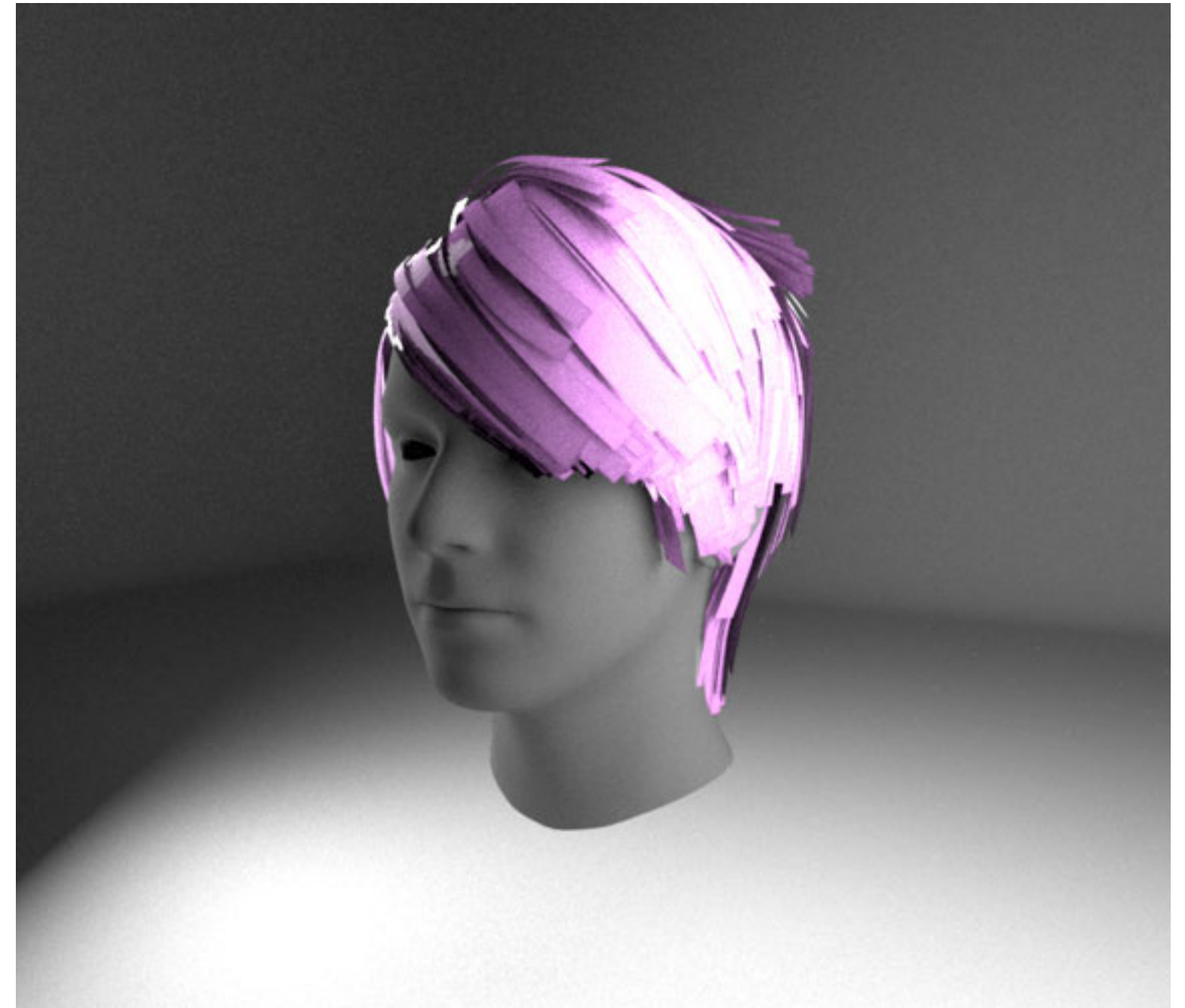
w/ visibility constraints

# **Hair Digitization**

# Hair Digitization



strands-level



strips-level

# Database Generation



USC-HairSalon (343)



our head model

# Database Generation



USC-HairSalon (343)



our head model

+



artist created (89)

# Database Generation



hairstyle A

+



hairstyle B

# Database Generation



hairstyle A

+



hairstyle B

=



combination

# Database Generation



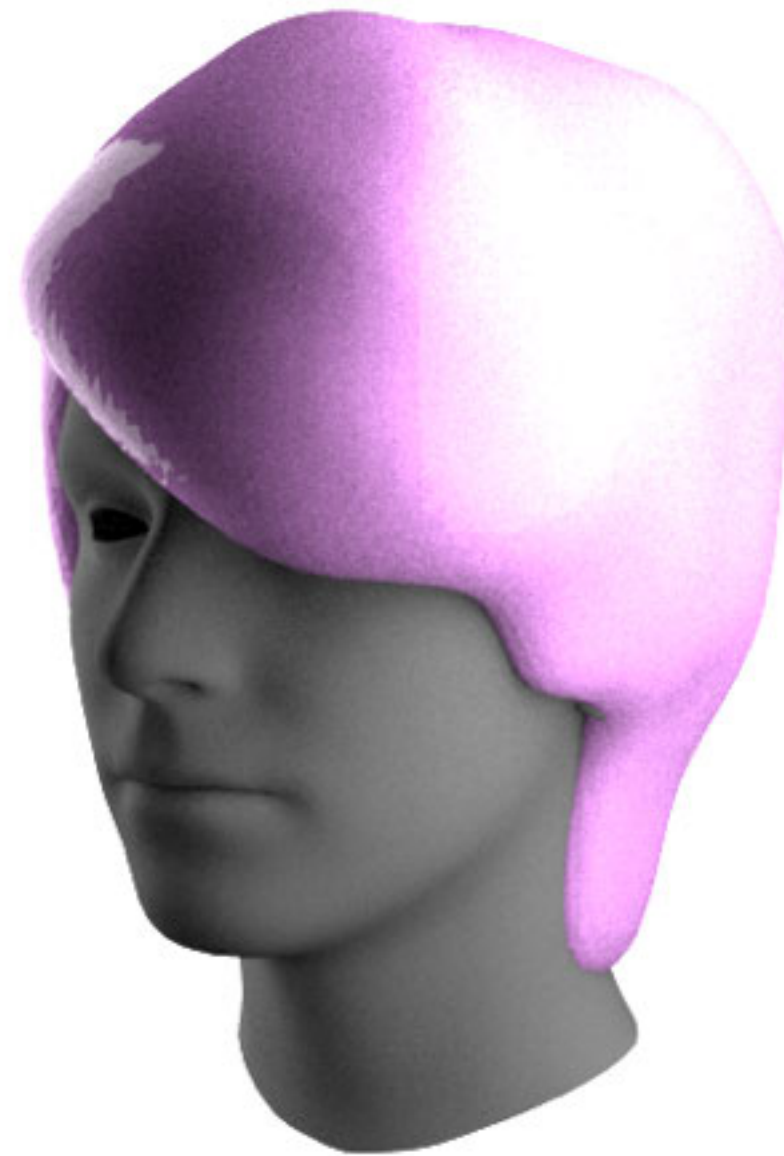
strands-level



# Database Generation



strands-level

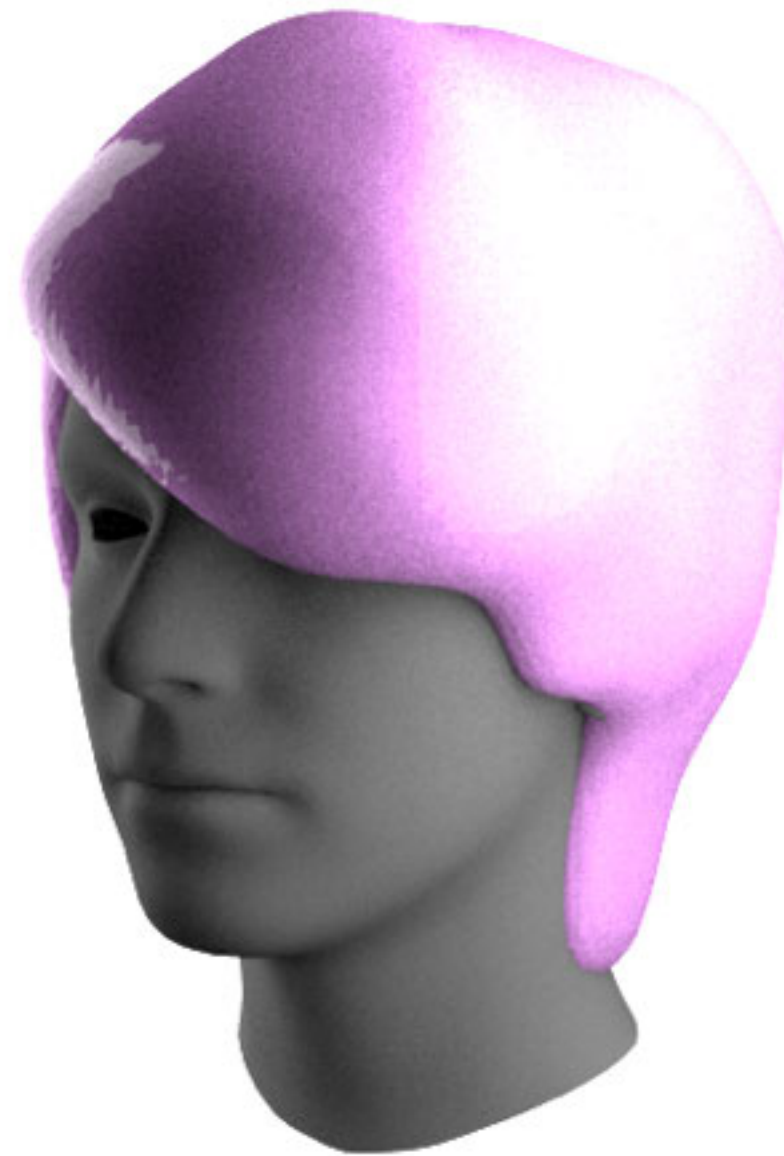


[Zhu and Bridson 2005]

# Database Generation



strands-level



[Zhu and Bridson 2005]



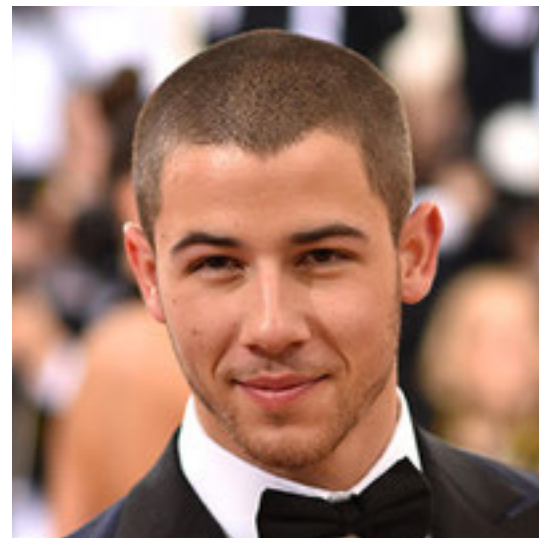
[Luo et al. 2013]

# Hair Attribute Extration

hair length



bald



shaved



short

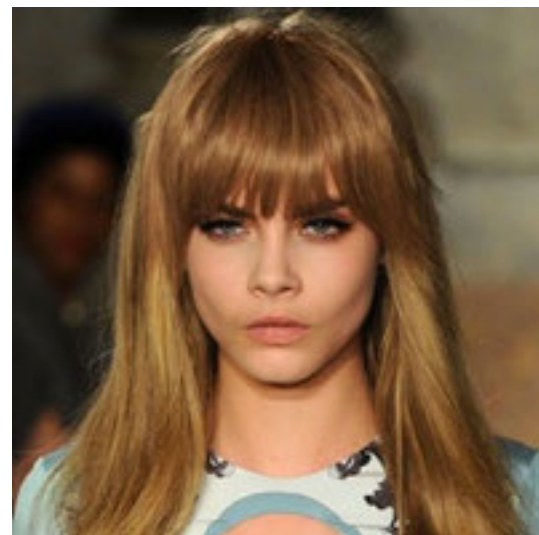


long

fringe



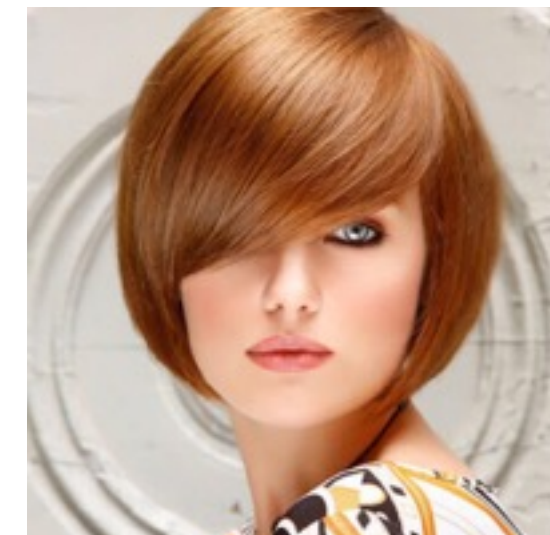
no fringe



full fringe



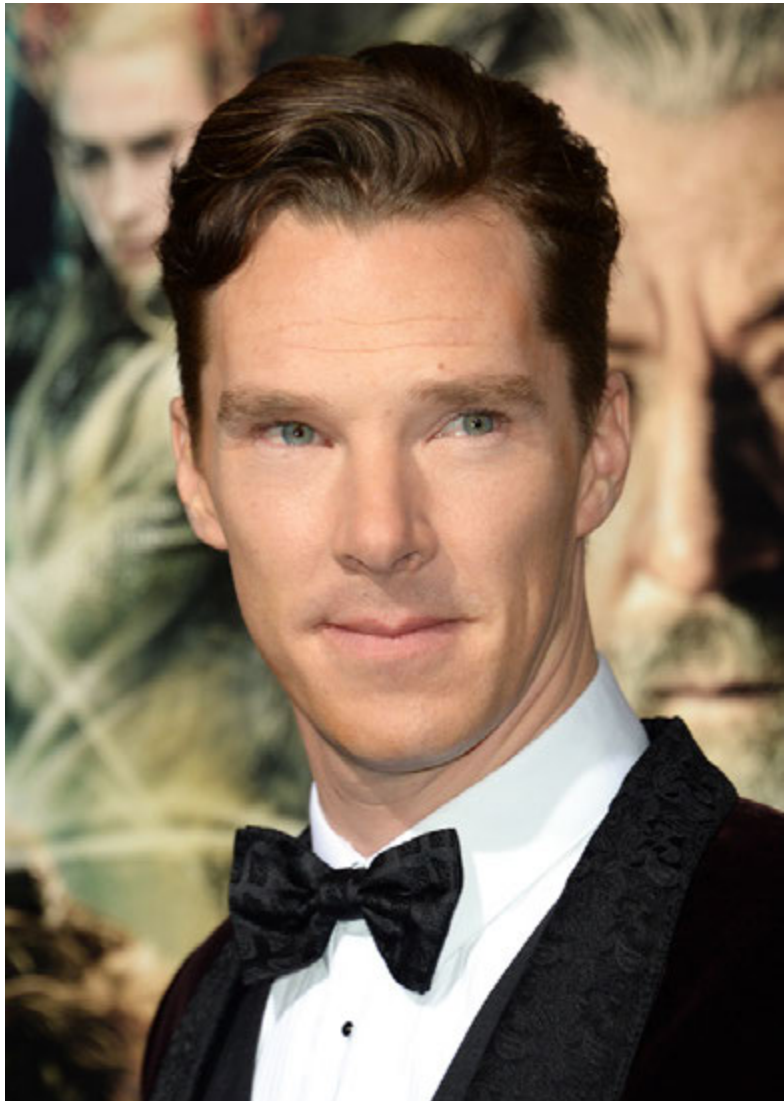
right fringe



left fringe

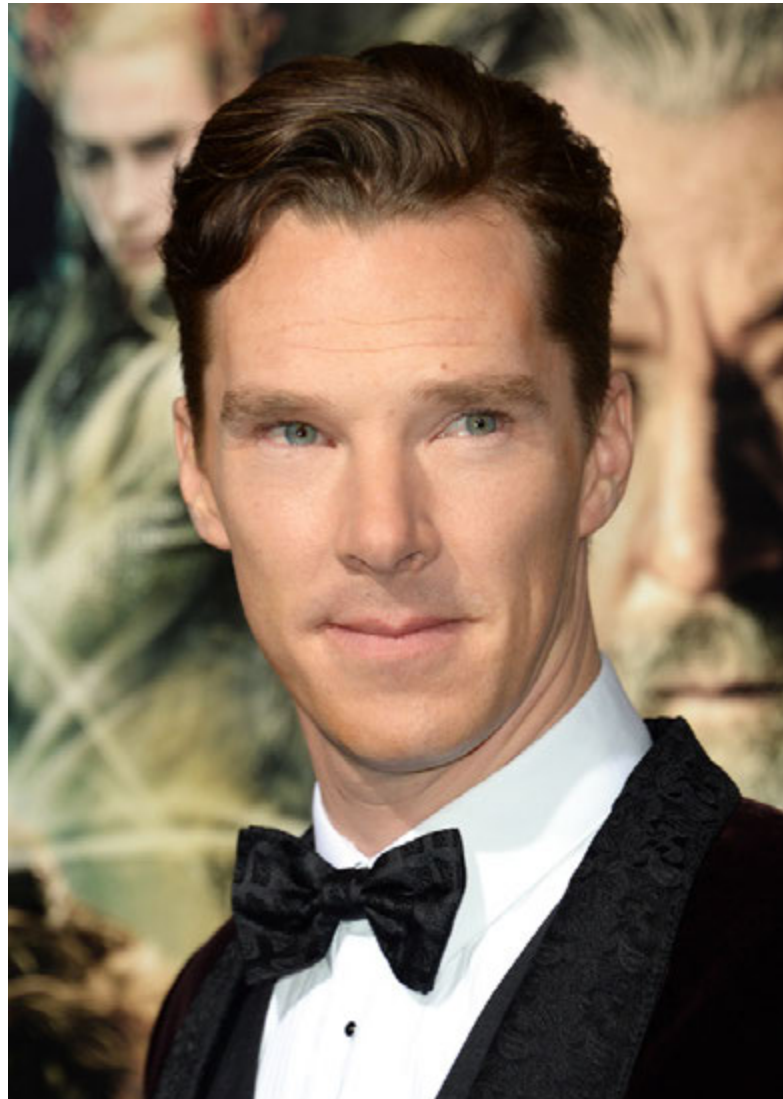
...

# Hair Attribute Extration



input image

# Hair Attribute Extration



input image

hair attribute  
extraction



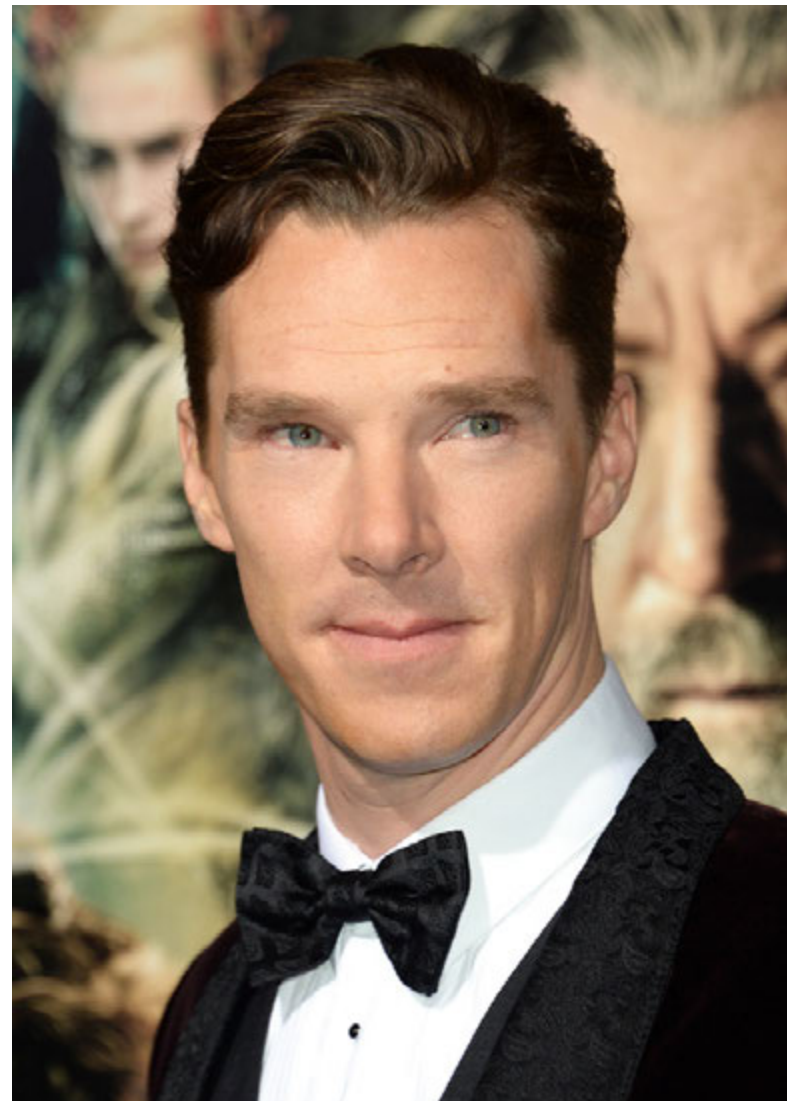
Short

curly

not spiky



# Hair Attribute Extration



input image

hair attribute  
extraction

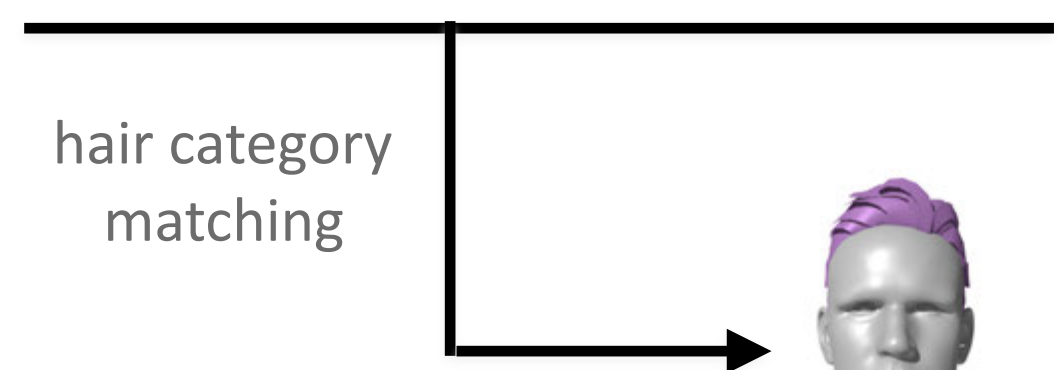


Short  
curly not spiky



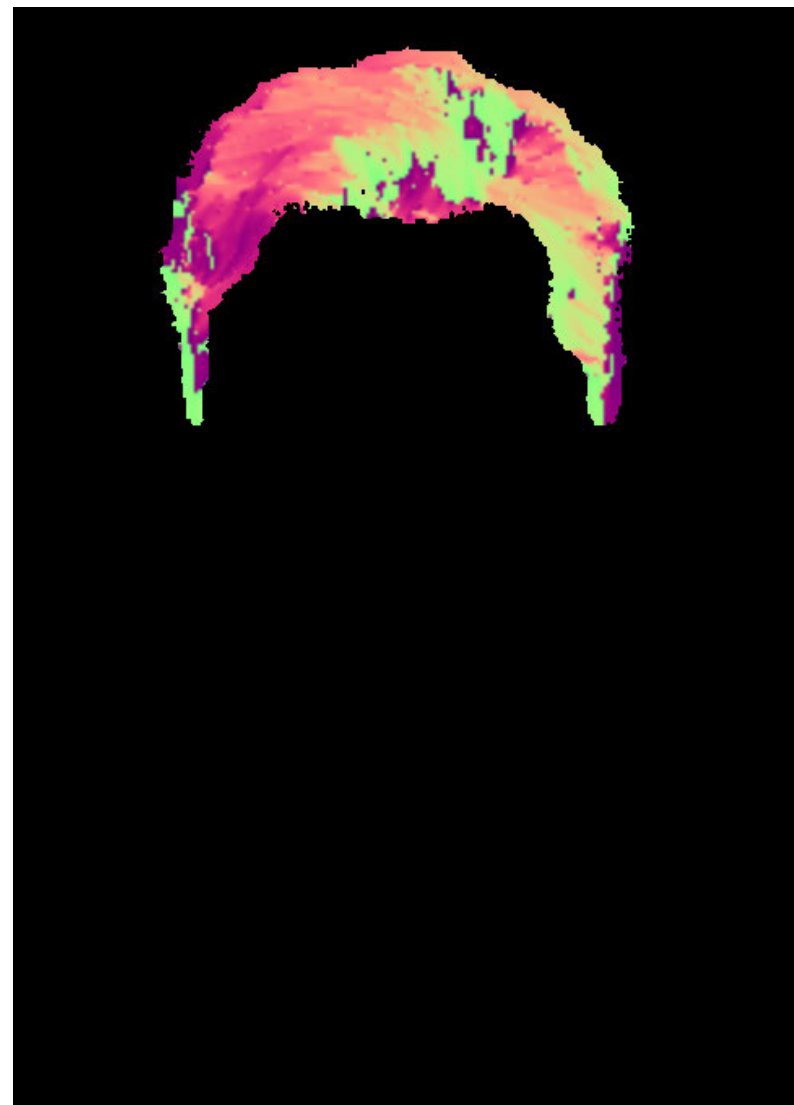
hairstyle database

hair category  
matching



reduced dataset

# Hairstyle Retrieval



segmentation  
and orientation

hair attribute  
extraction

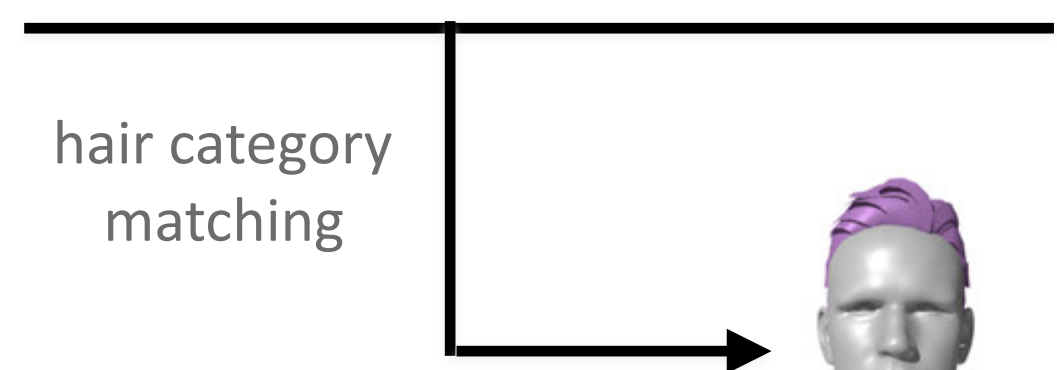


Short  
curly not spiky



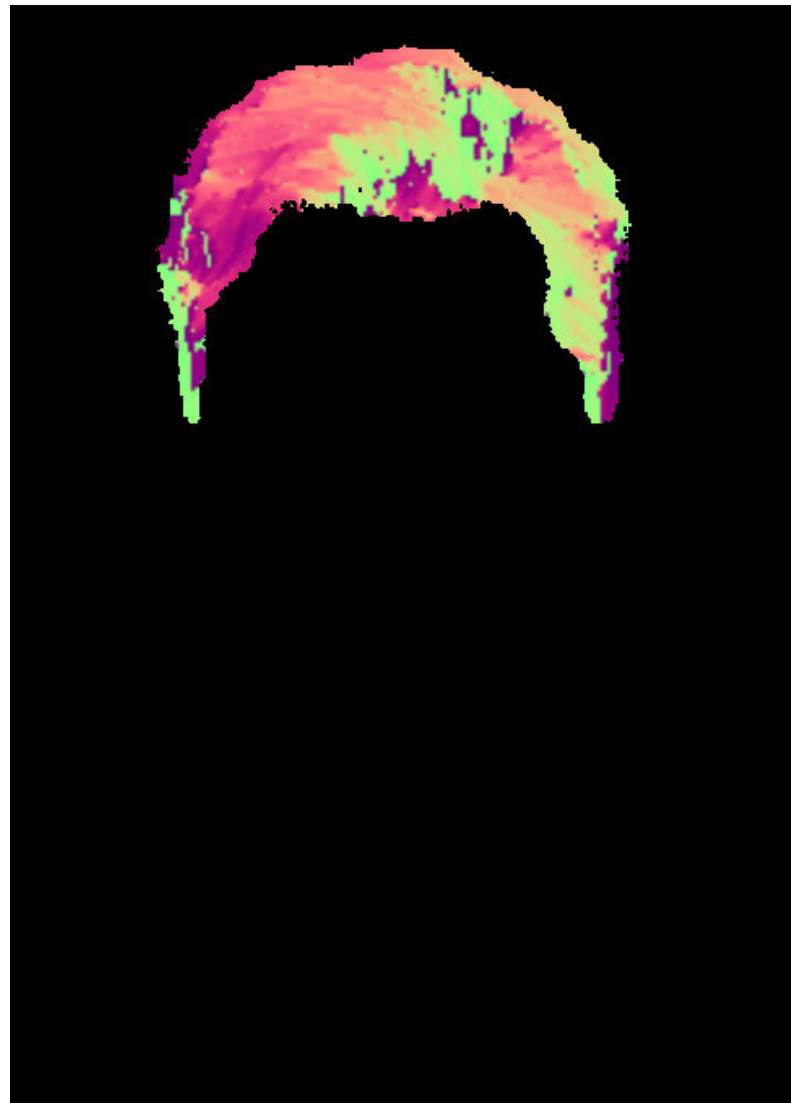
hairstyle database

hair category  
matching



reduced dataset

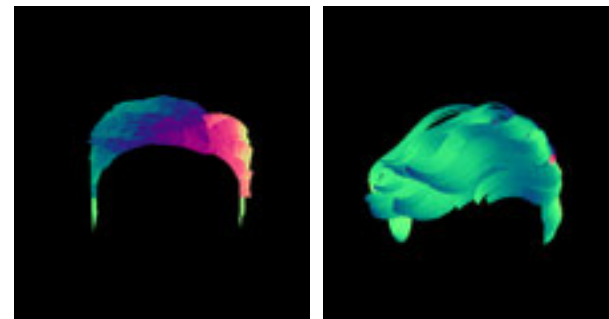
# Hairstyle Retrieval



segmentation  
and orientation



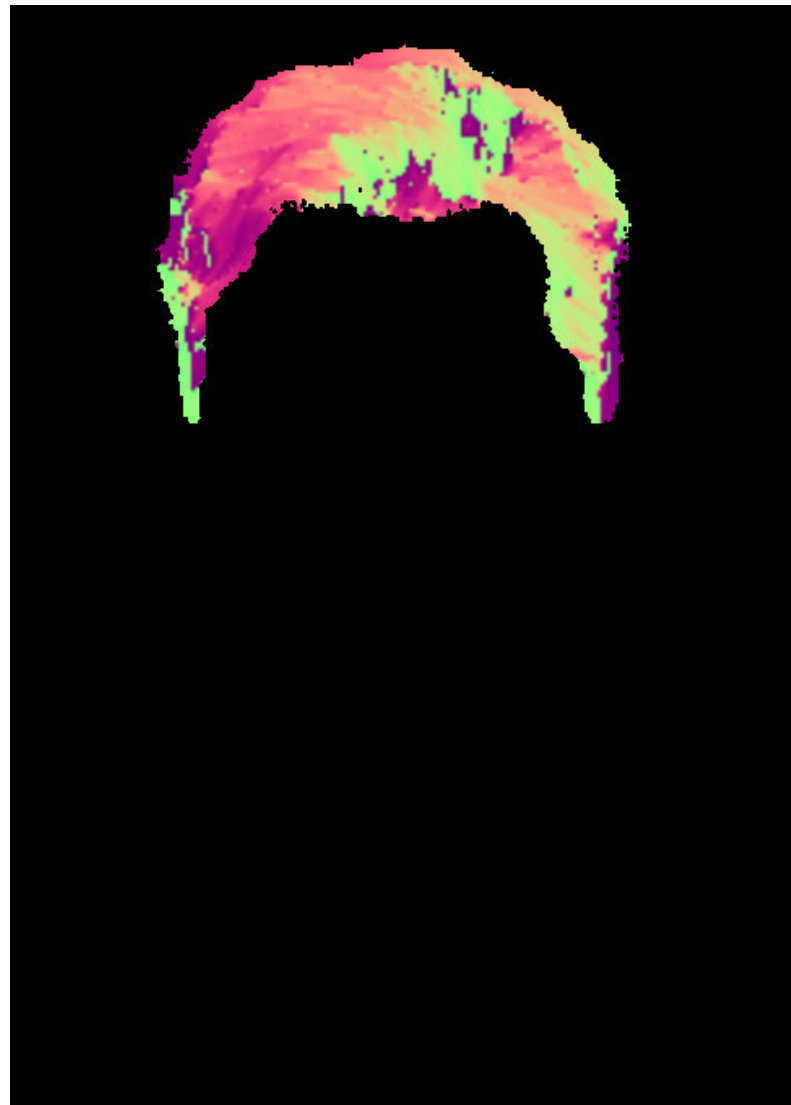
reduced dataset



thumbnails



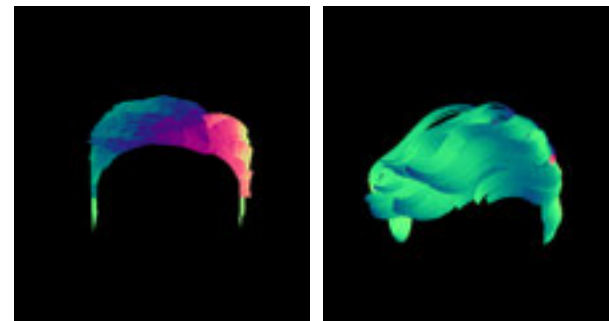
# Hairstyle Retrieval



segmentation  
and orientation



reduced dataset



thumbnails

hairstyle  
retrieval



closest hairstyle

# Hair Mesh Fitting



input image



closest hairstyle

# Hair Mesh Fitting



input image

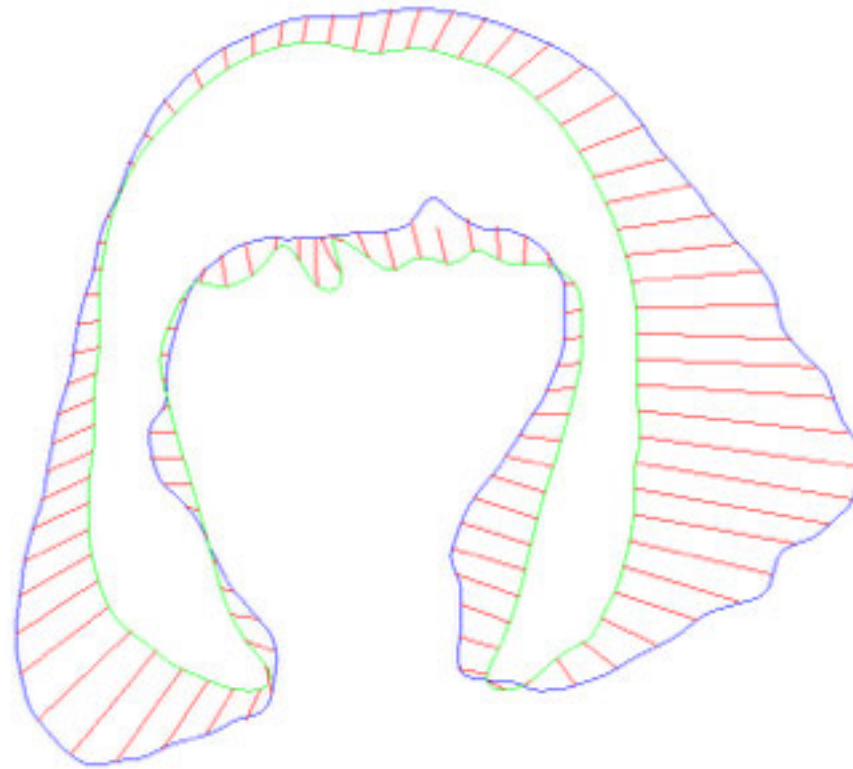


head fitting deformation

# Hair Mesh Fitting



input image



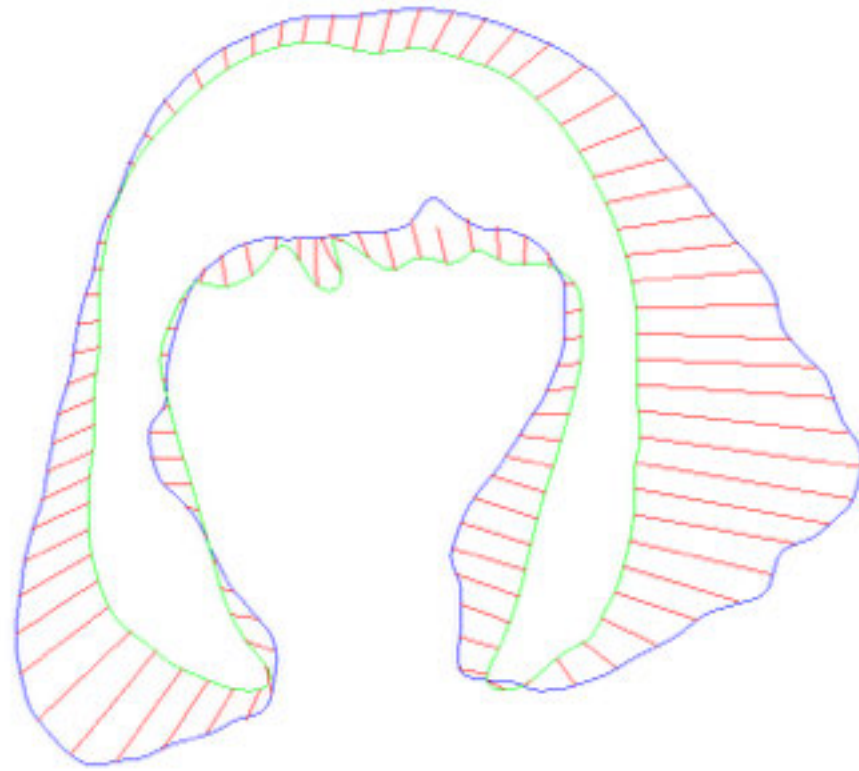
mask deformation



# Hair Mesh Fitting



input image



mask deformation



# Hair Mesh Fitting



input image



collision detection

# Hair Mesh Fitting



input image



collision detection

# Hair Rendering and Texturing

hair curve



straight



wavy



curly



dreadlock



# Hair Rendering and Texturing

hair curve



straight



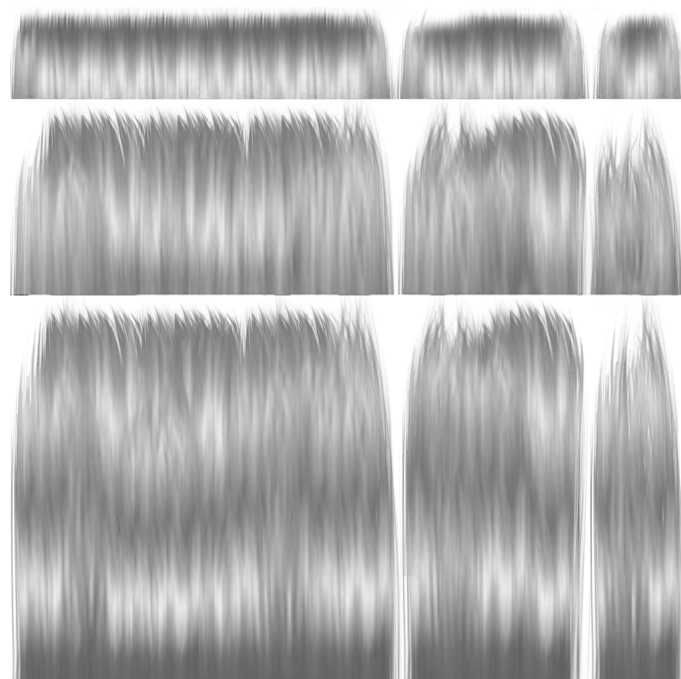
wavy



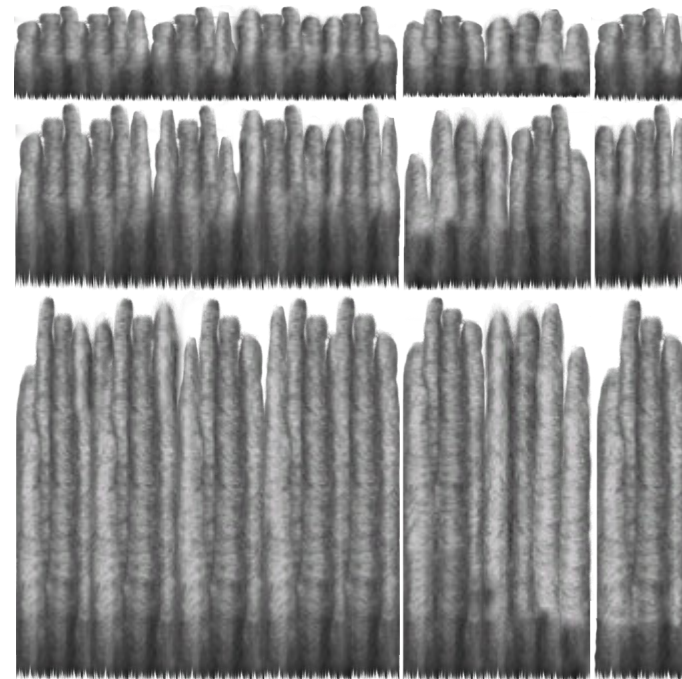
curly



dreadlock



straight



dreadlock



wavy

# Hair Rendering and Texturing



# Polystrip Patching Optimization

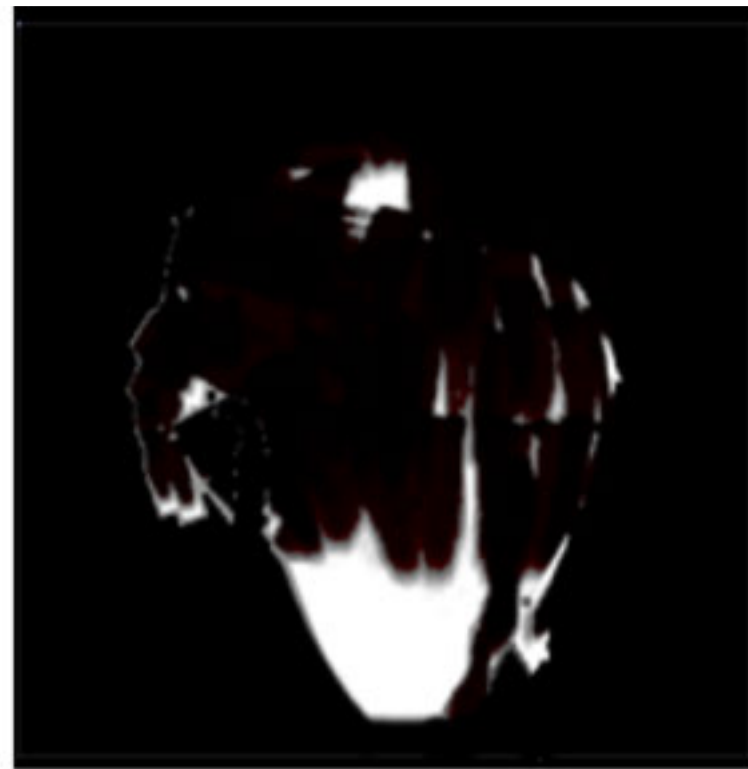


input hair model

# Polystrip Patching Optimization



input hair model

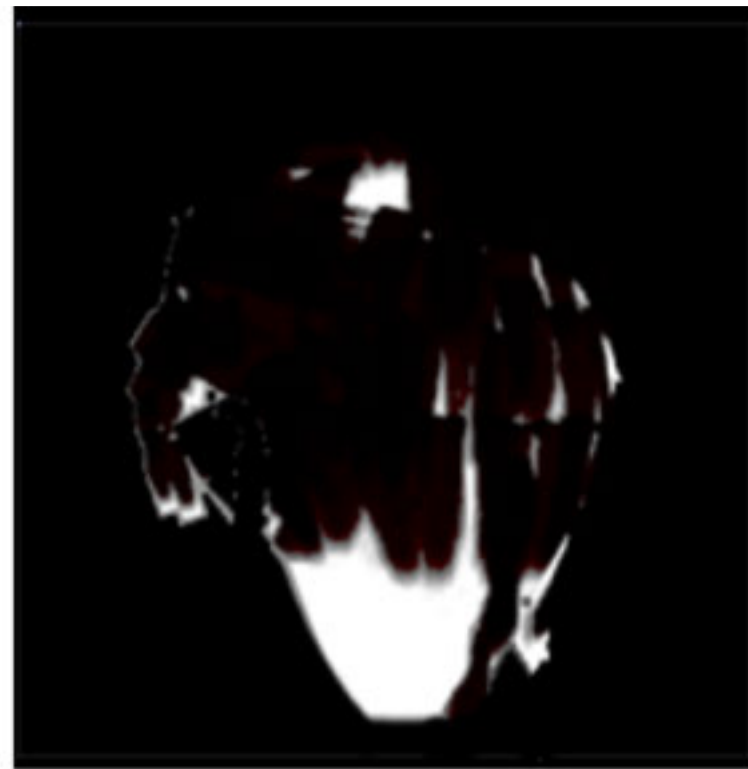


multi-view scalp  
visibility map

# Polystrip Patching Optimization



input hair model



multi-view scalp  
visibility map

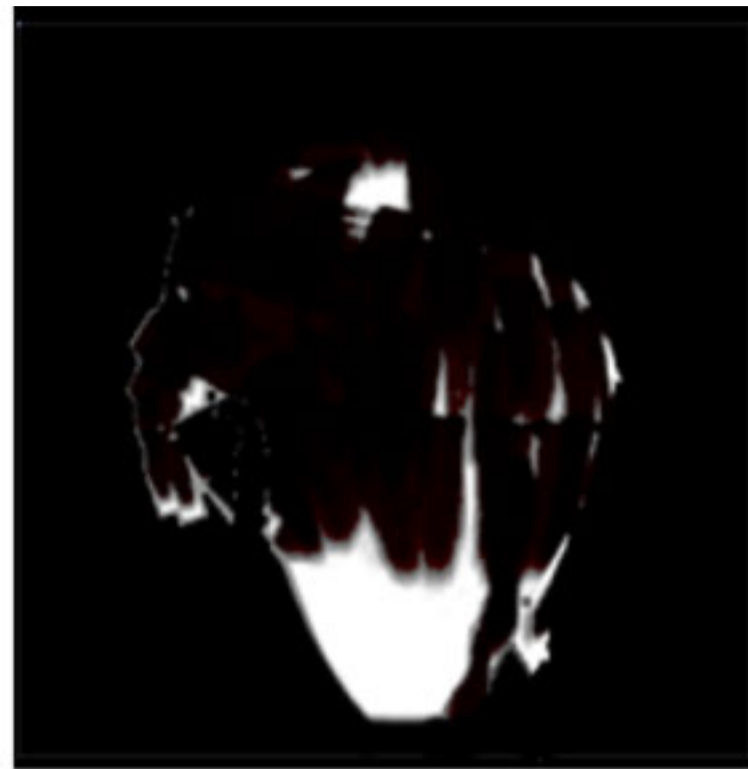


iteration 1

# Polystrip Patching Optimization



input hair model



multi-view scalp  
visibility map



iteration 1



final result

# Results

# Results



input image



face and hair mesh



3D avatar



# Results

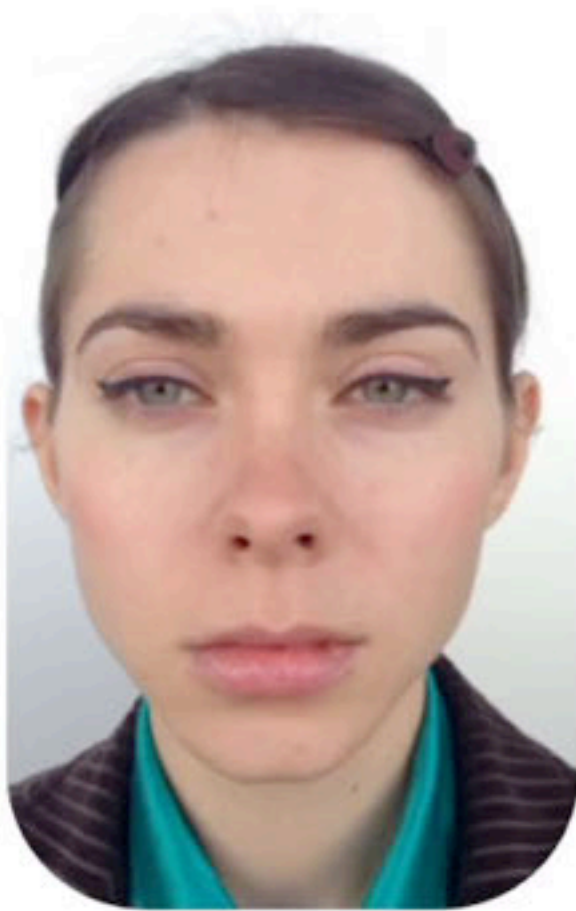


input image



3D avatar

# Comparisons



input image



[Ichim et al. 2015]  
(multi-view and no hair)



our method

# Comparisons



input image



[Chai et al. 2016]



our method

# Comparisons



input image



[Chai et al. 2016]



our method

# Conclusion



# Future Work

"digital emily"



# Future Work



# Thanks!



**USC** Institute for  
Creative Technologies