3D Parametric Face Model and Its Applications in games

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NetEase Games AI LAB

Overview

- What is a 3D Parametric Face Model

- How to build a 3D Parametric Face Model

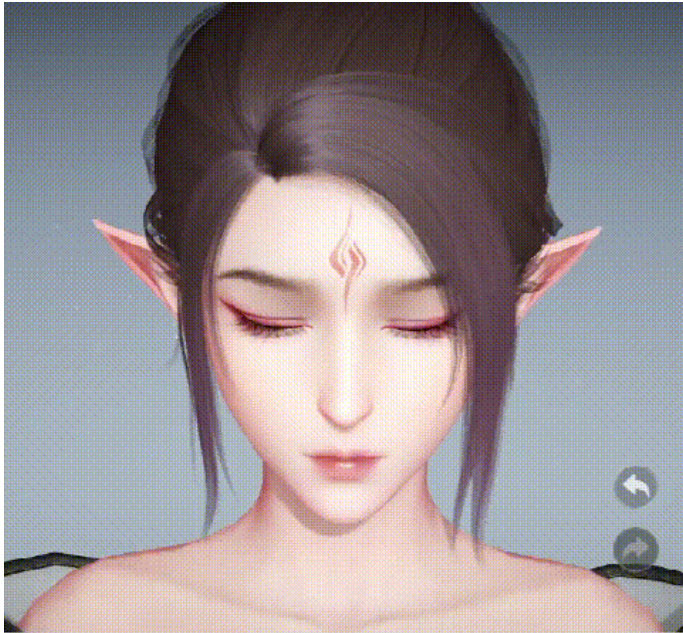- Applications in games

What is a
3D Parametric Face Model

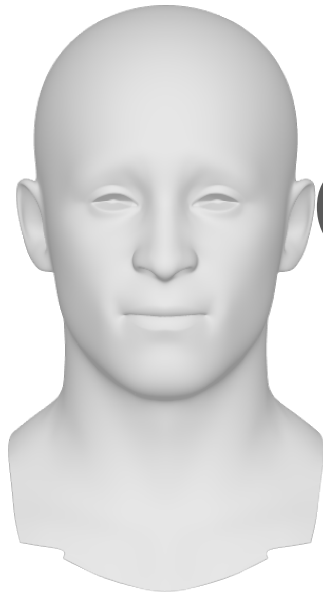3D Facial Assets

3D Parametric Face Model

3D Facial Assets

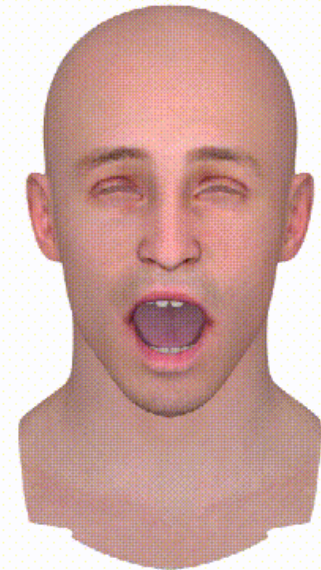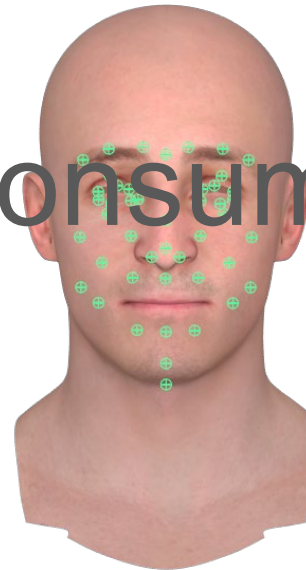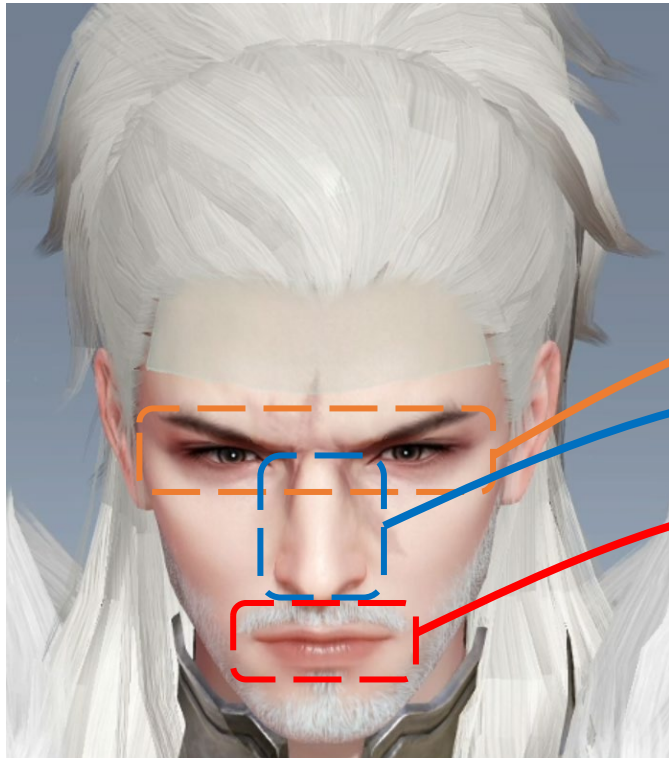# 3D Facial Assets

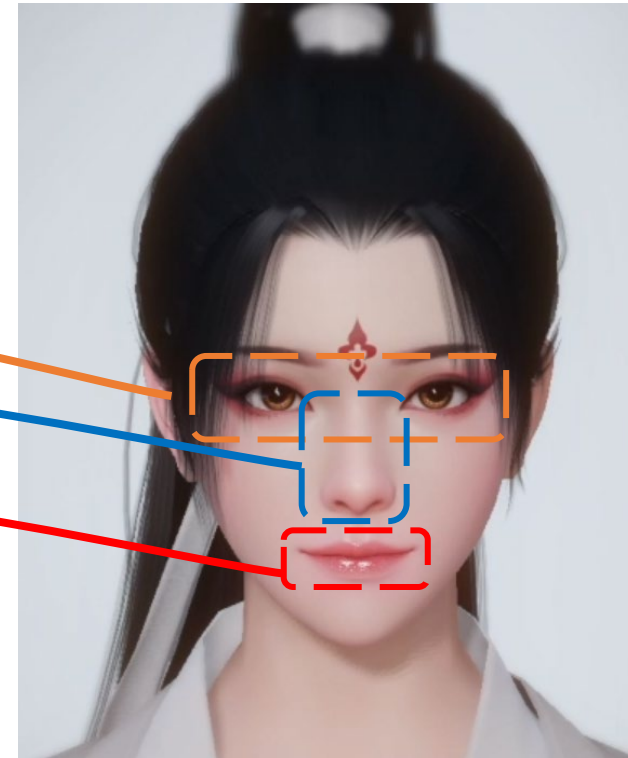3D modeling   Texture &materials   Rigging   Animation

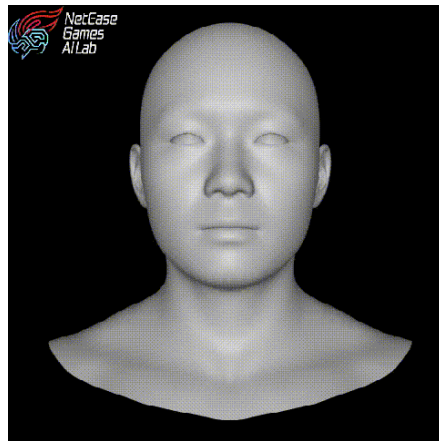Costly & time-consuming

3D Facial Assets
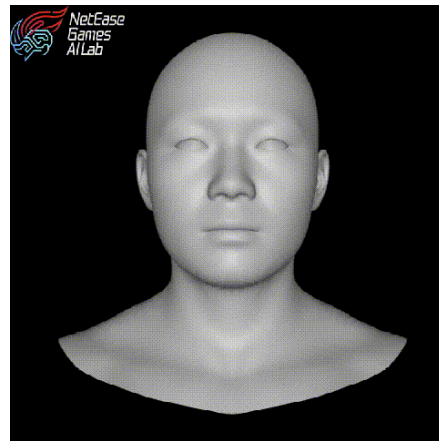

Two eyes

One Nose

One Mouth

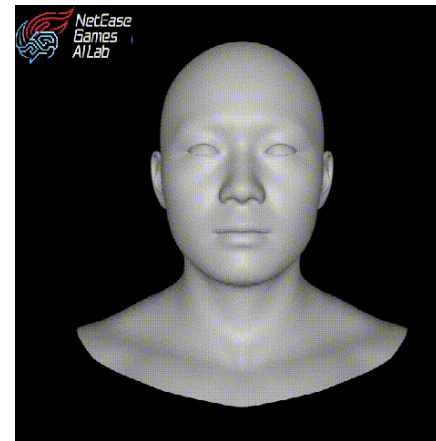# 3D Parametric Face Model

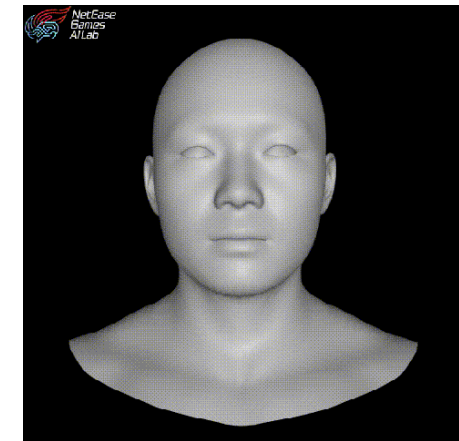
3D Parametric
Face Model

Shape Facial attribute Expression Appearance

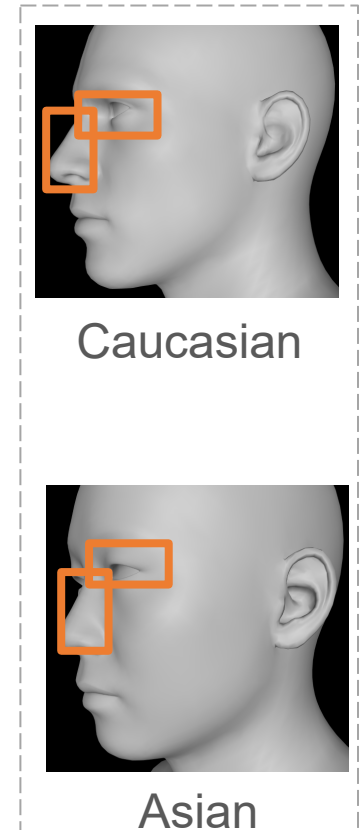# How to build a 3D Parametric Face Model

Data preparation

Shape

Facial attribute

Expression

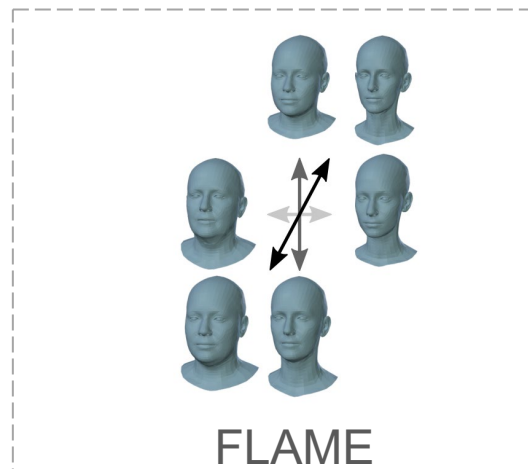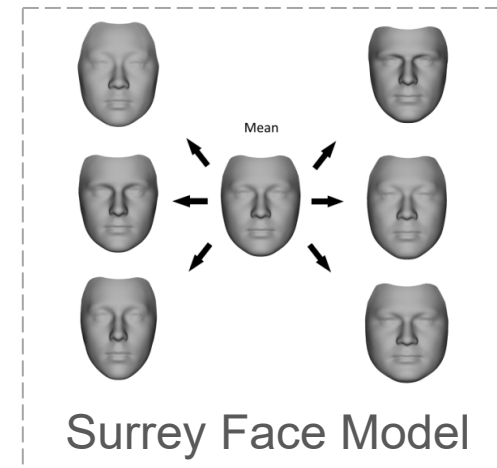Appearance

3D Parametric Face Model

Blanz, Volker, and Thomas Vetter. "A morphable model for the synthesis of 3D faces." SIGGRAPH. 1999.

Basel Face Model

Surrey Face Model

FLAME

CoMA

Caucasian

Asian
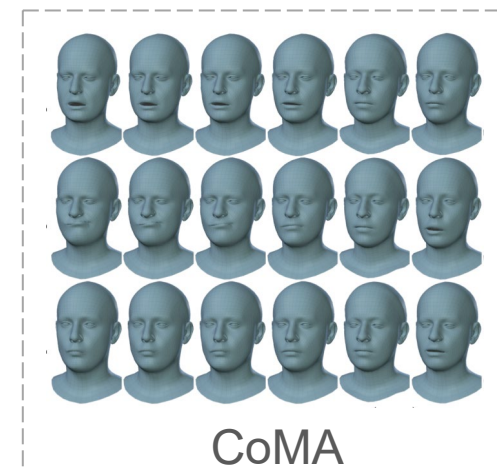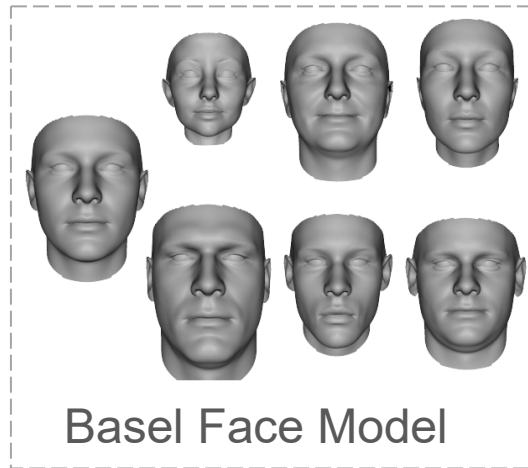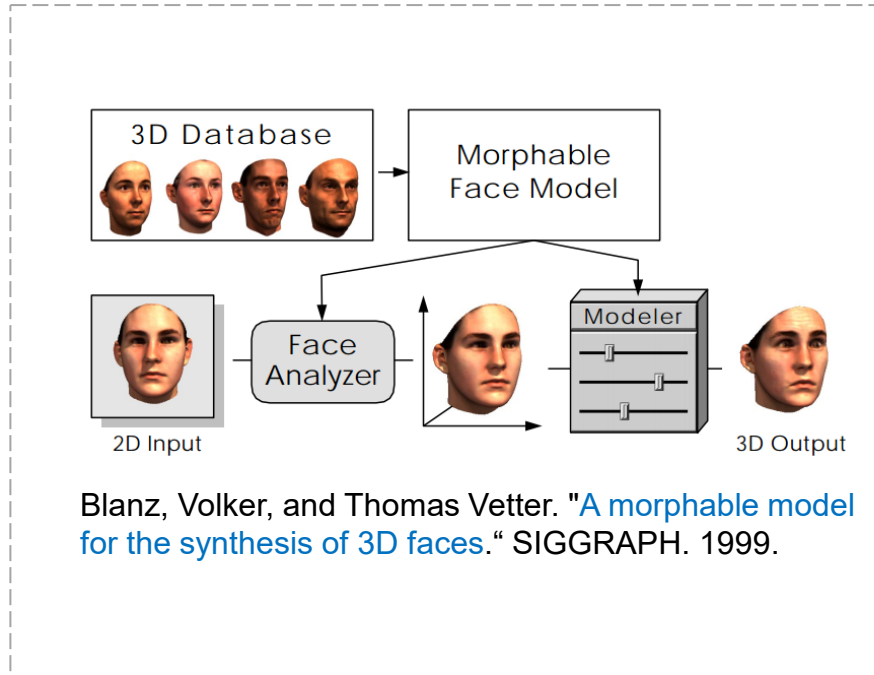
NTES Face Model: Data Preparation

- 500 Face scan
  - Half male, half female
  - Aged from 10 to 60

...

NTES Face Model: Data Preparation

Scanned model

Game model

NTES Face Model: Data Preparation

Reference

Deformed model
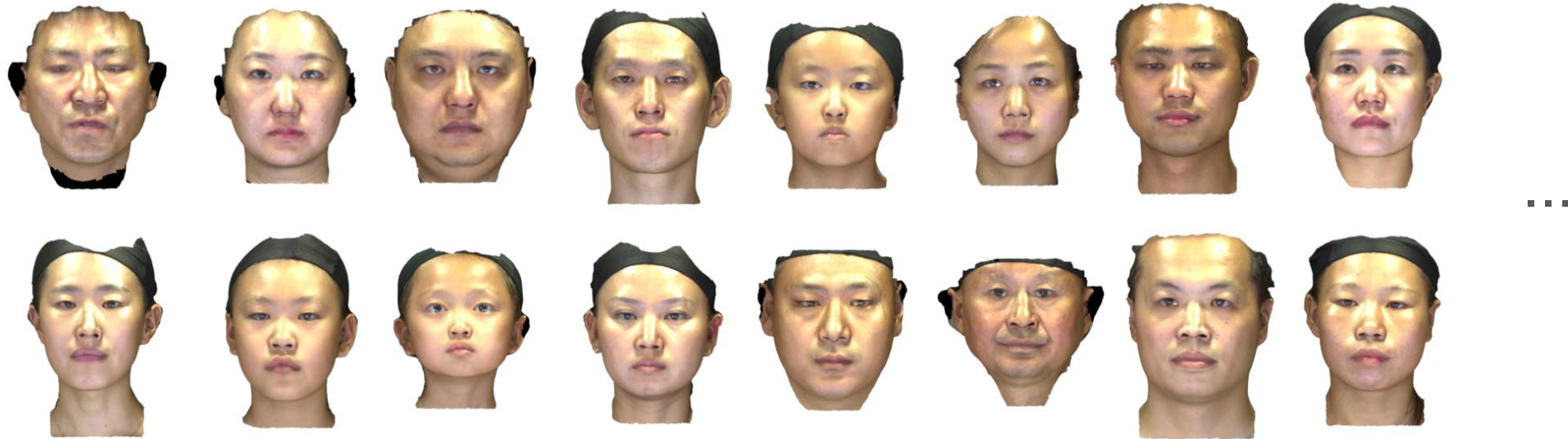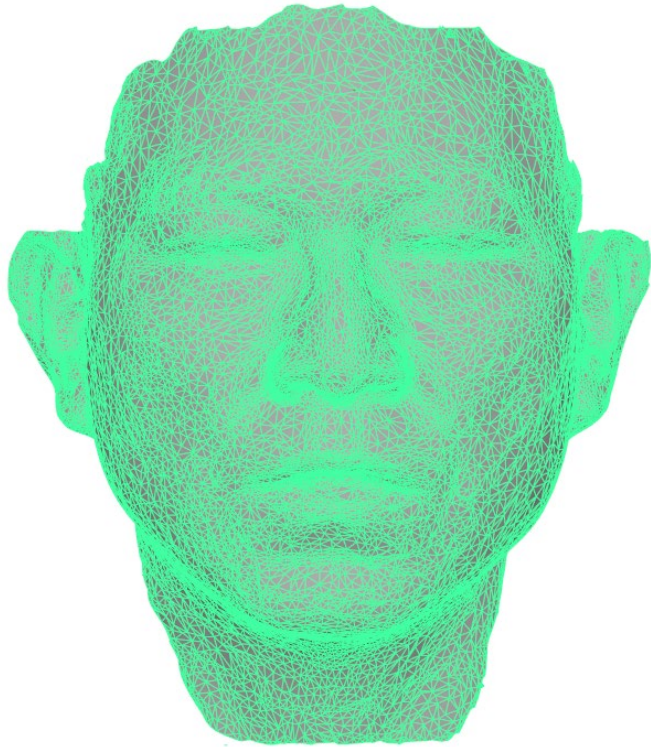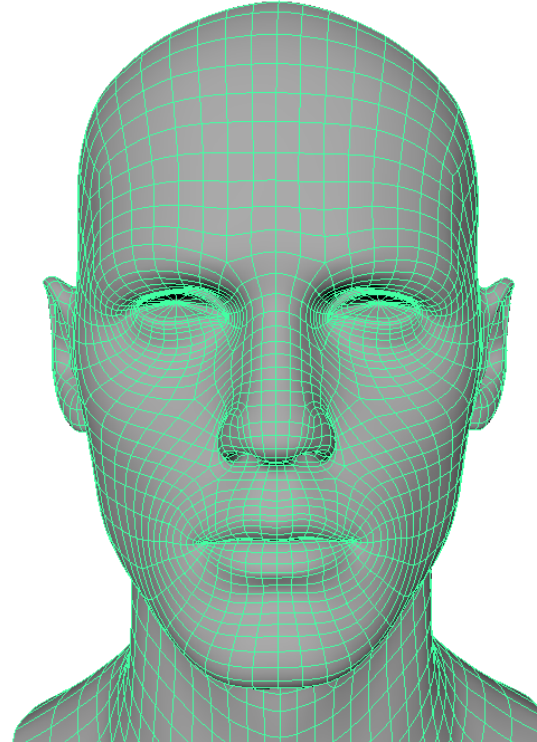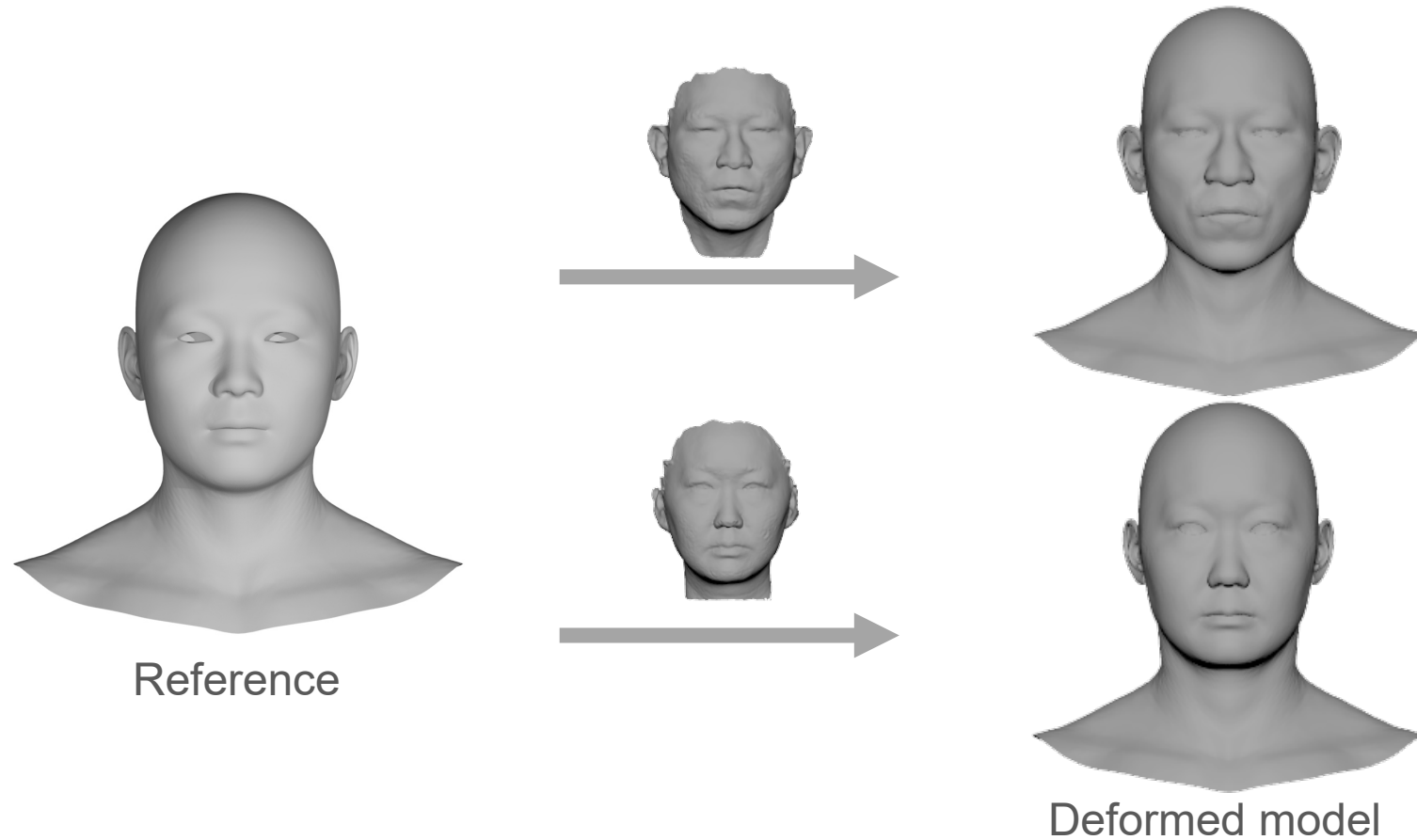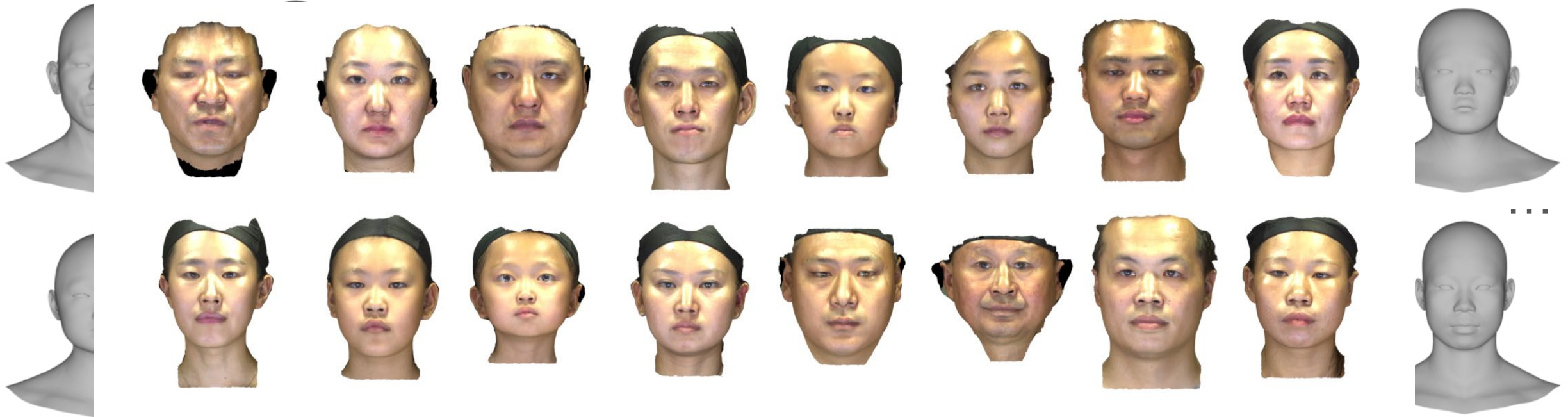
NTES Face Model: Data Preparation

NTES Face Model: Data Preparation

Reference

Expressions

...
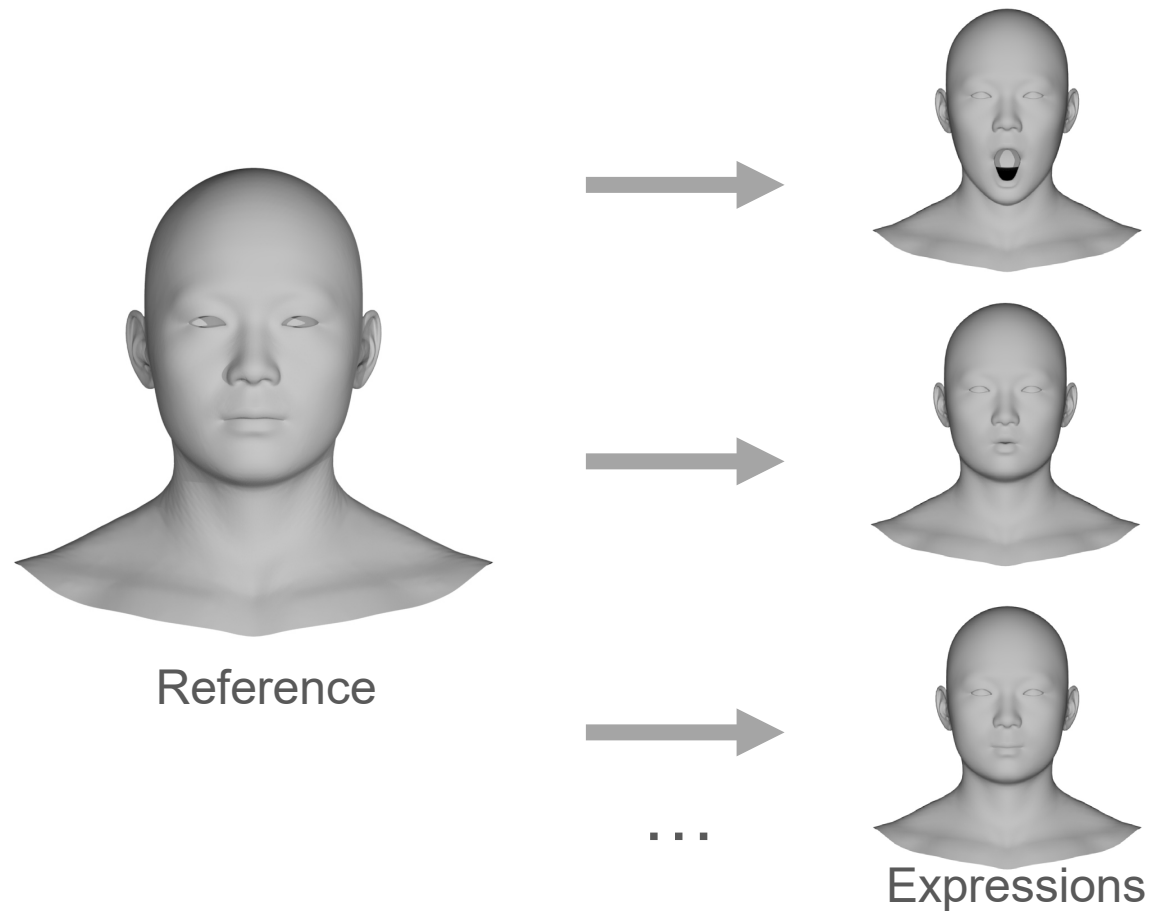
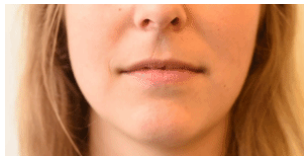# NTES Face Model: Data Preparation

FACS
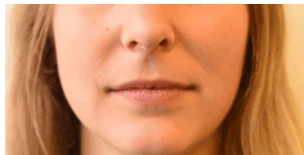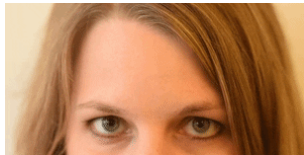
Template expressions

NTES Face Model: Data Preparation

NTES Face Model: Shape
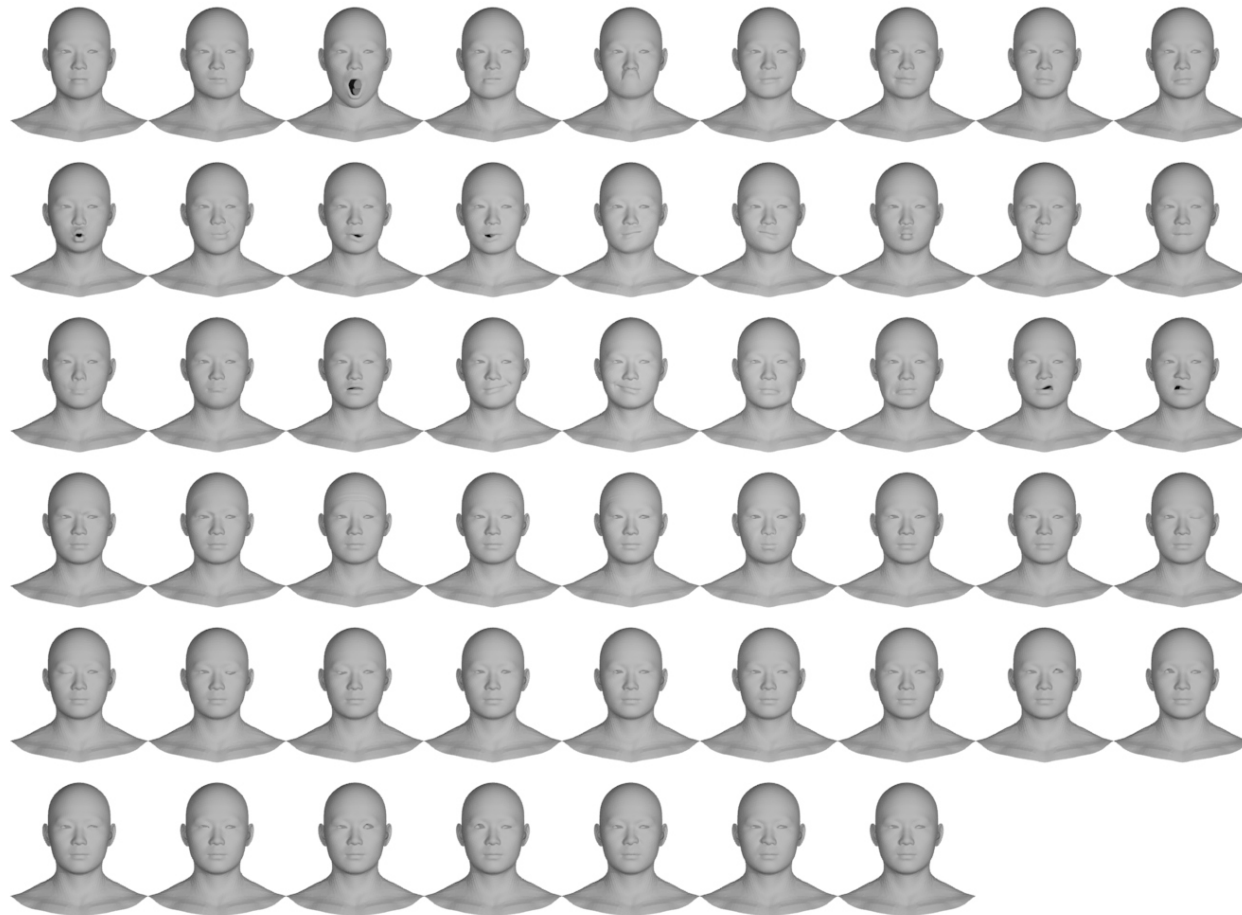
Tucker Decomposition
Principal Component Analysis
Encoder-decoder
...
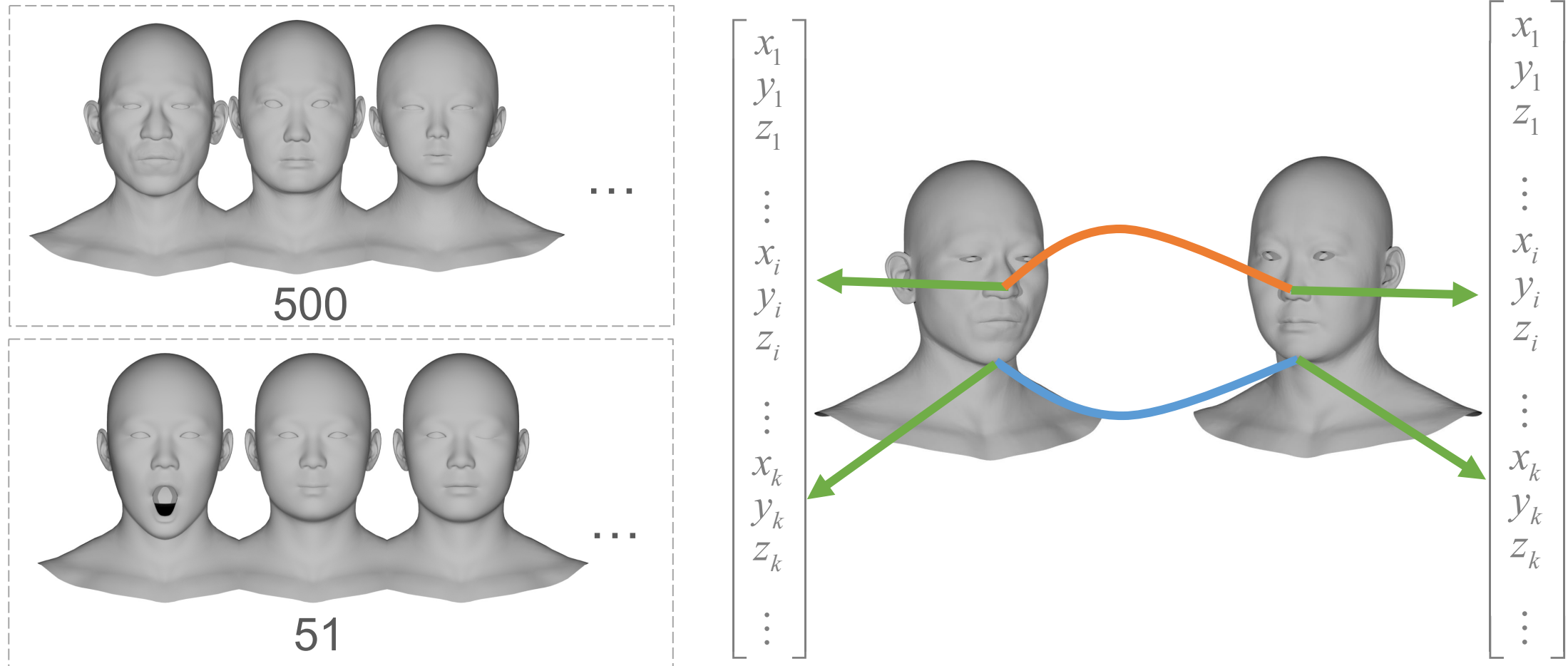
$$\text{face} = f(\,\text{face}_1\,,\,\text{face}_2\,,\,\text{face}_3\,\ldots\,)$$

$$\text{face} = a_0\,\text{face} + a_1\,\text{face} + a_2\,\text{face}\,\ldots$$

500

PCA

Shape parameter space

$$\begin{bmatrix} V_0 & V_1 & V_2 & \cdots \end{bmatrix}$$

NTES Face Model: Shape

c0 = 2.5   c0 = -2.5

c1 = 2.5   Mean   c1 = -2.5

c2 = 2.5   c2 = -2.5

NTES Face Model: Shape

Head height

Wider mouth

Jaw width

c_0

c_1

c_2
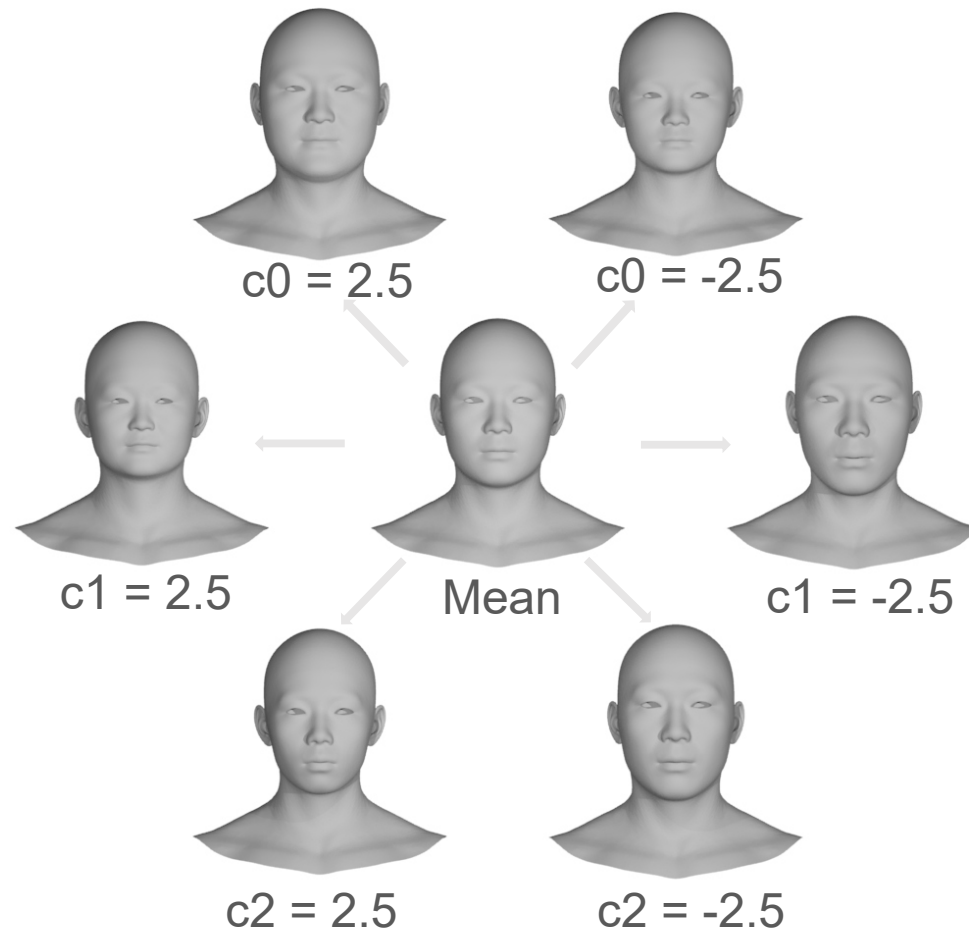
Head height

Mouth width
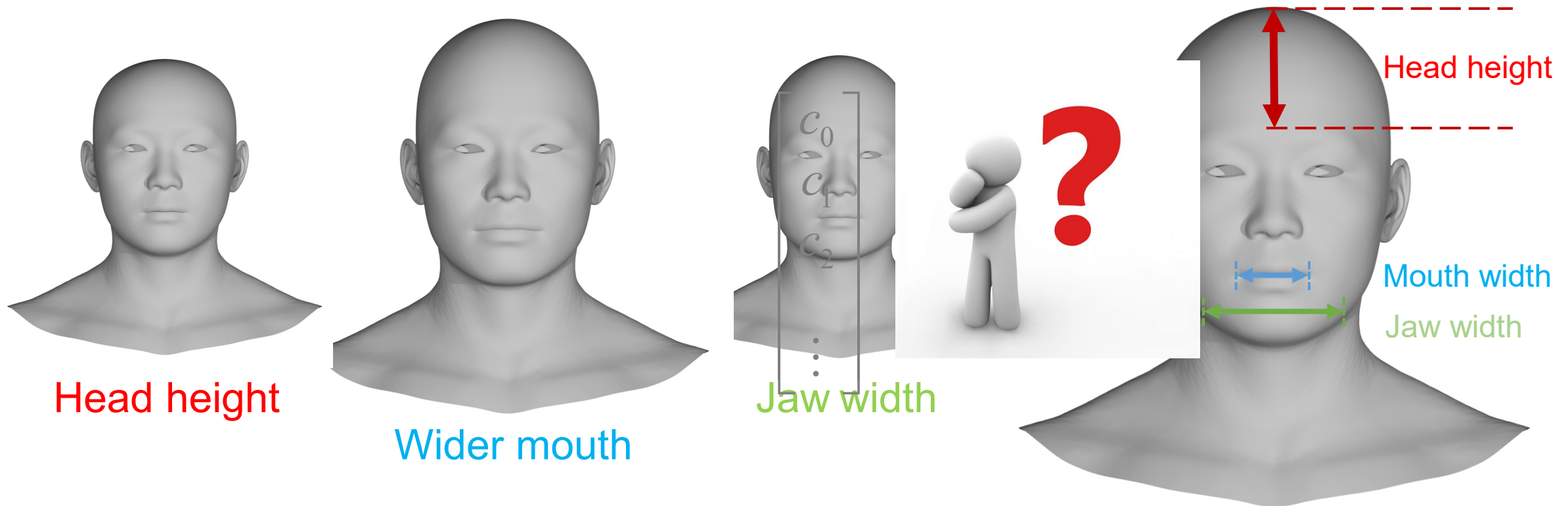
Jaw width

NTES Face Model: Facial Attribute

Facial Attribute	measurement
Face width	m0
Face height	m1
Eye width	m2
Nose width	m3
Mouth width	m4
Forehead height	m5
Jaw width	m6
......	......

$$\begin{bmatrix} m_0 \\ m_1 \\ m_2 \\ \vdots \end{bmatrix}$$

Face width

Nose width

Mouth width

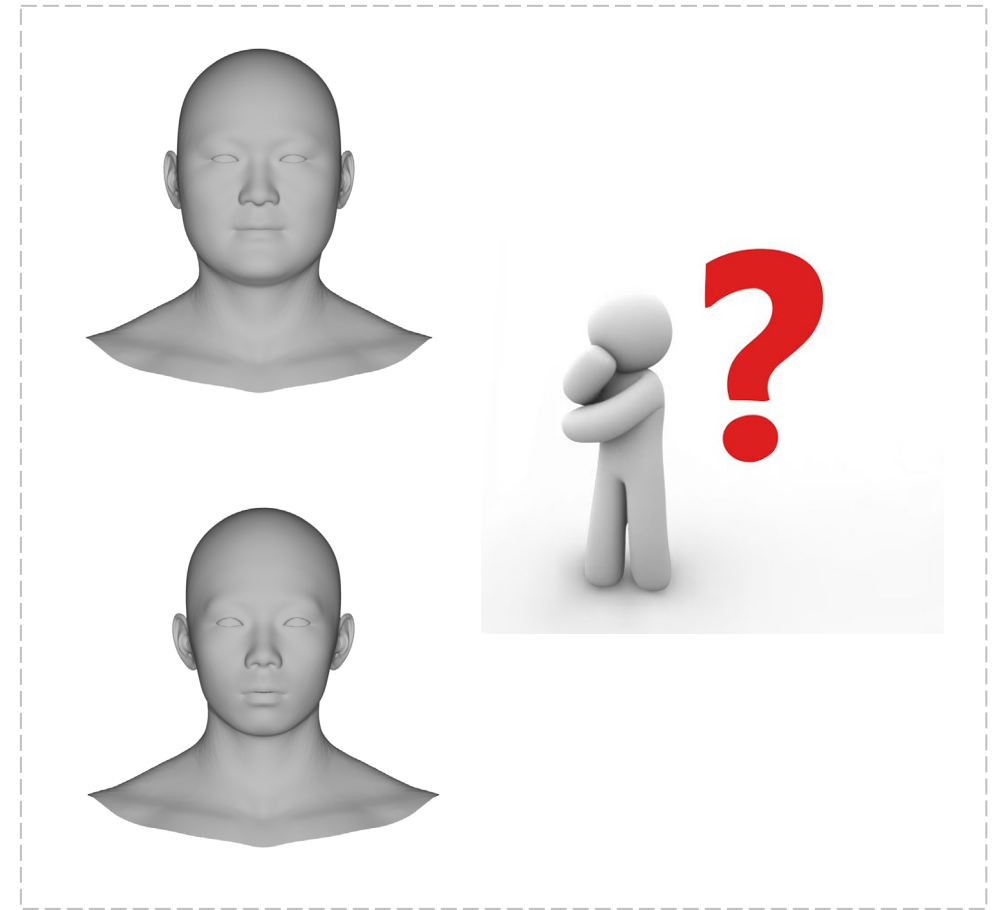Face height
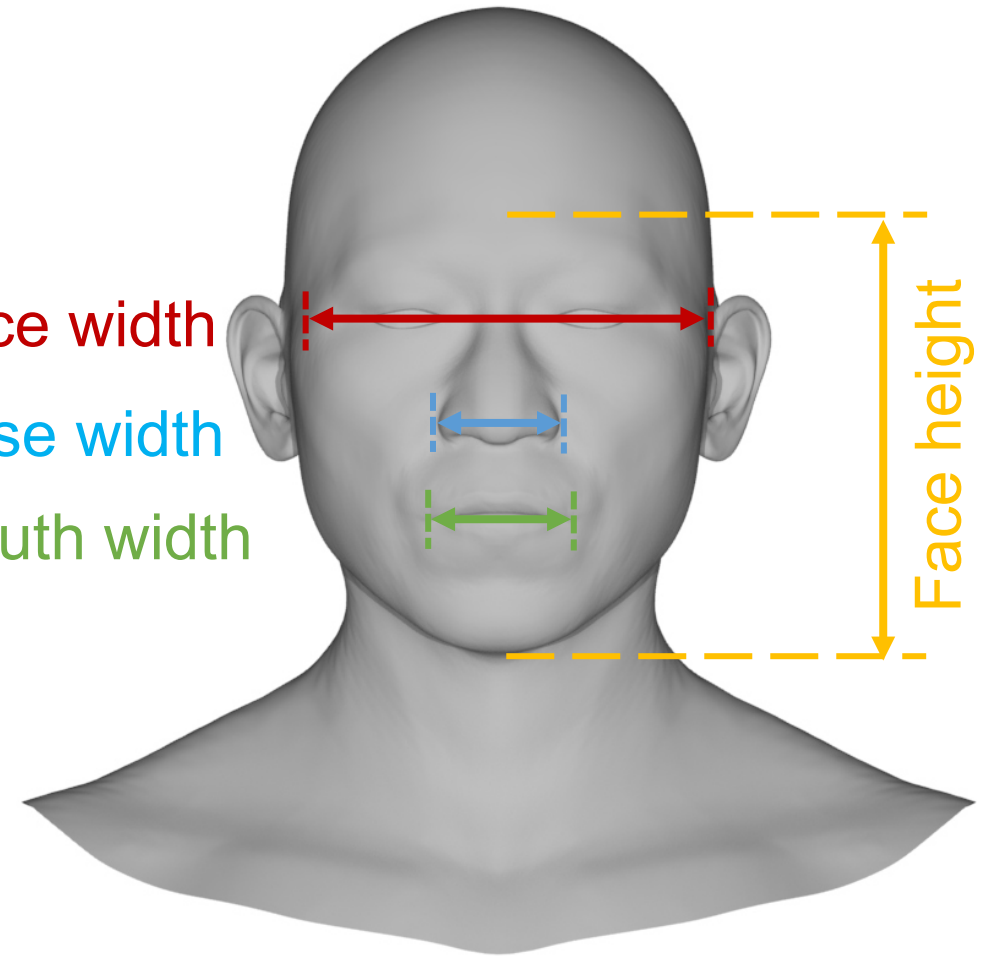
NTES Face Model: Facial Attribute

Mapping matrix

Facial Attribute

$$\begin{bmatrix} m_0 \\ m_1 \\ m_2 \\ \vdots \end{bmatrix}$$

Shape

$$\begin{bmatrix} c_0 \\ c_1 \\ c_2 \\ \vdots \end{bmatrix}$$

...

NTES Face Model: Facial Attribute

Eye size

Double chin

Nose width

Mean

Mouth width

Head height

Jaw width

NTES Face Model: Expression

Mean

Mouth-pucker
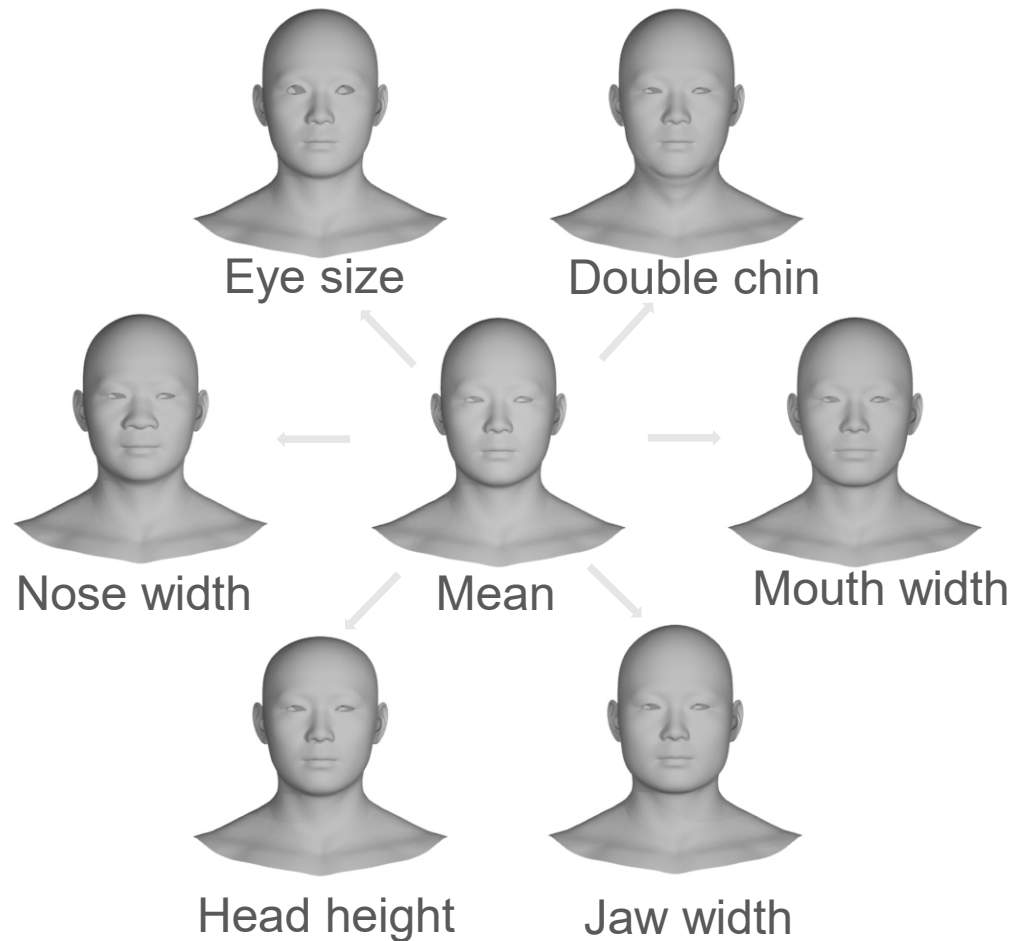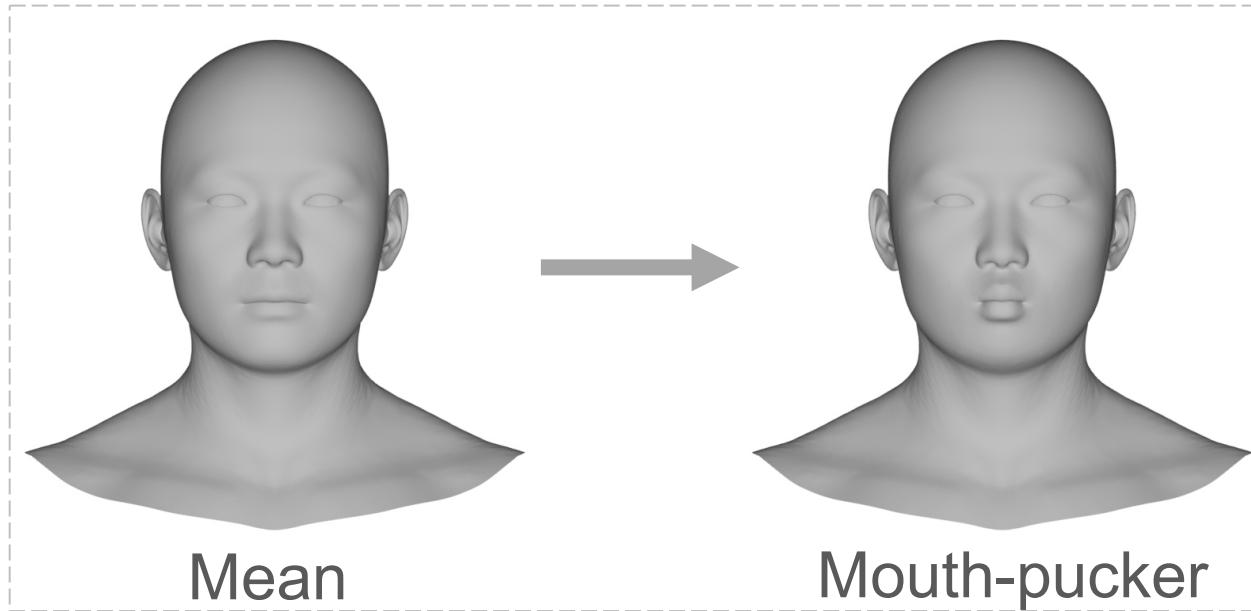
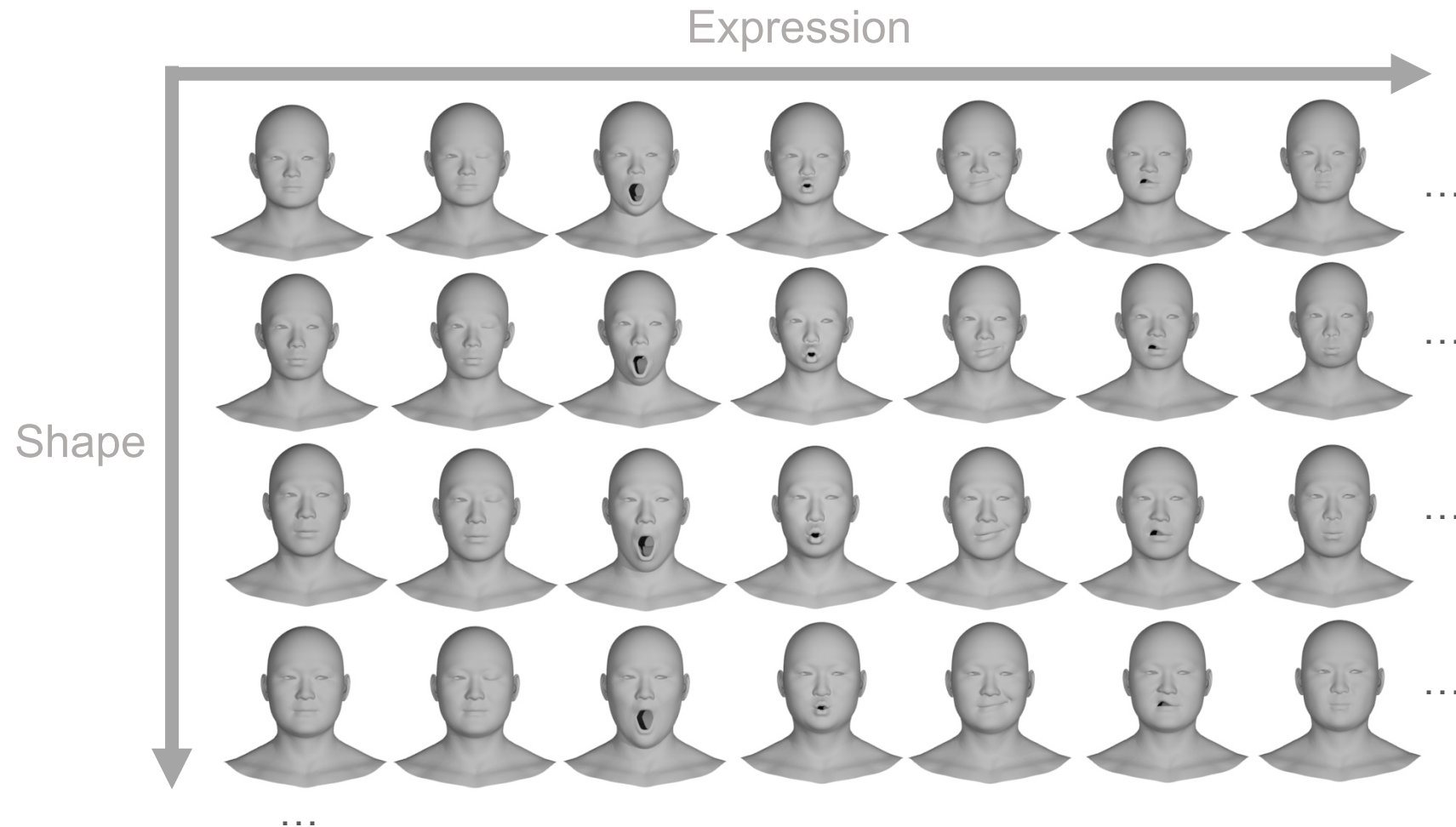# NTES Face Model: Expression

NTES Face Model

Expression

Shape

NTES Face Model: Appearance

NTES Face Model: Appearance

The scans

Deformed model

Displacement map

Texture map
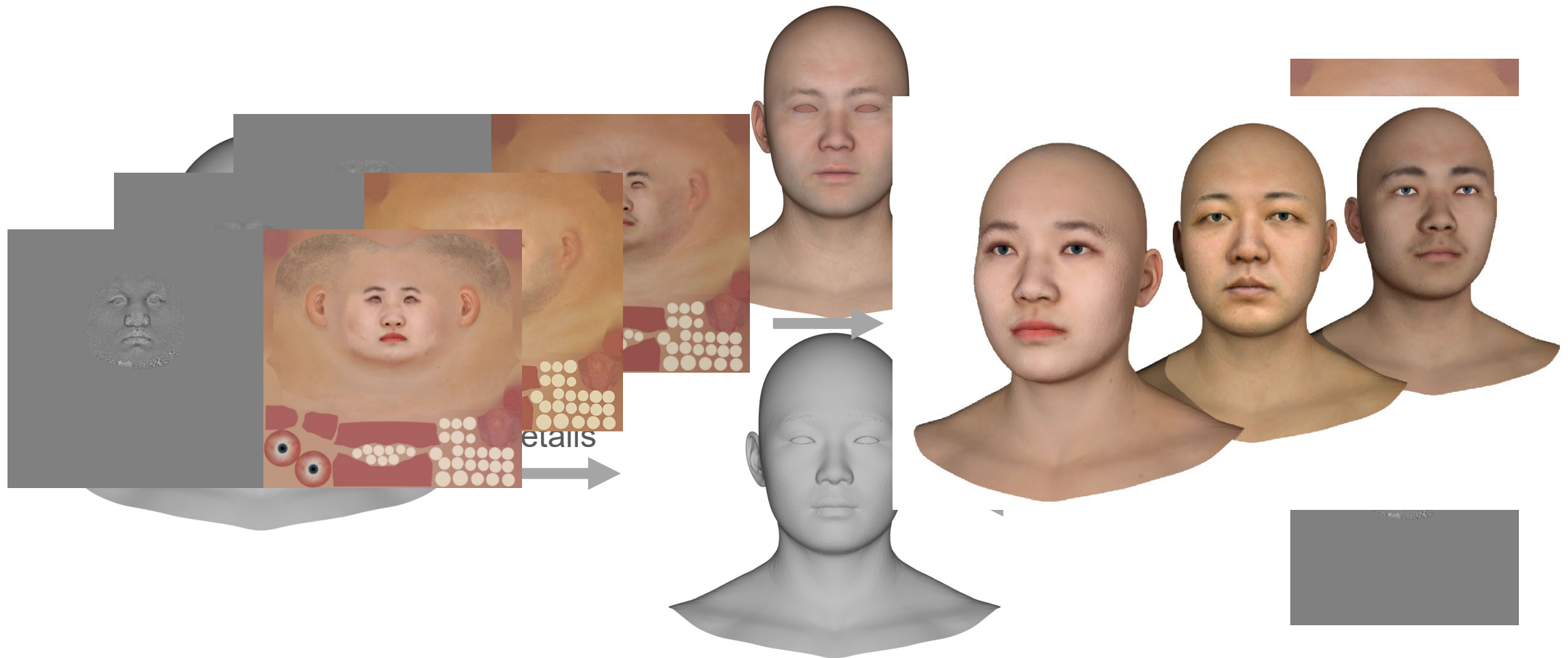
Face image
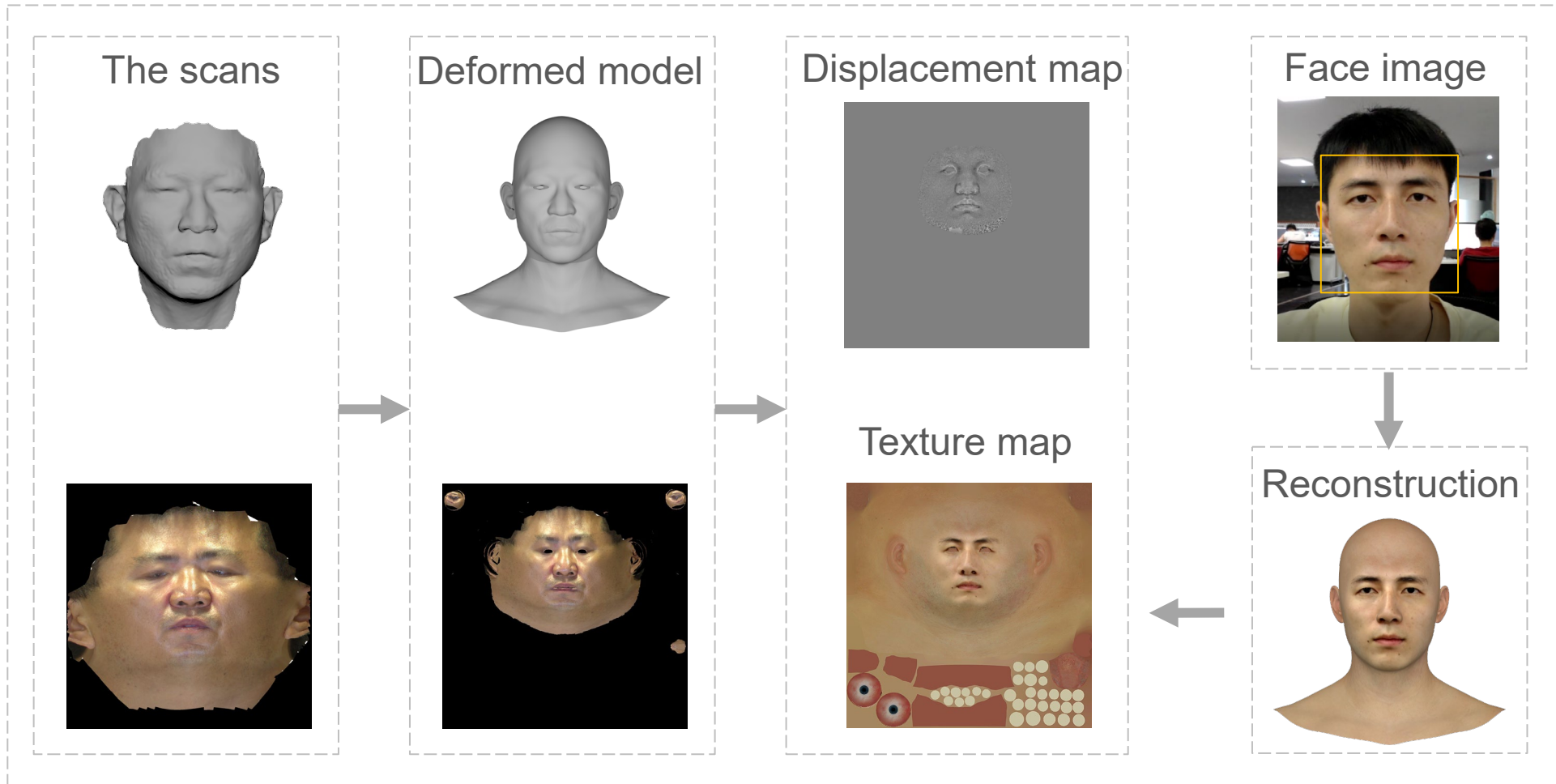
Reconstruction

Applications in games

3D Face Reconstruction

Shape & Expression Transfer
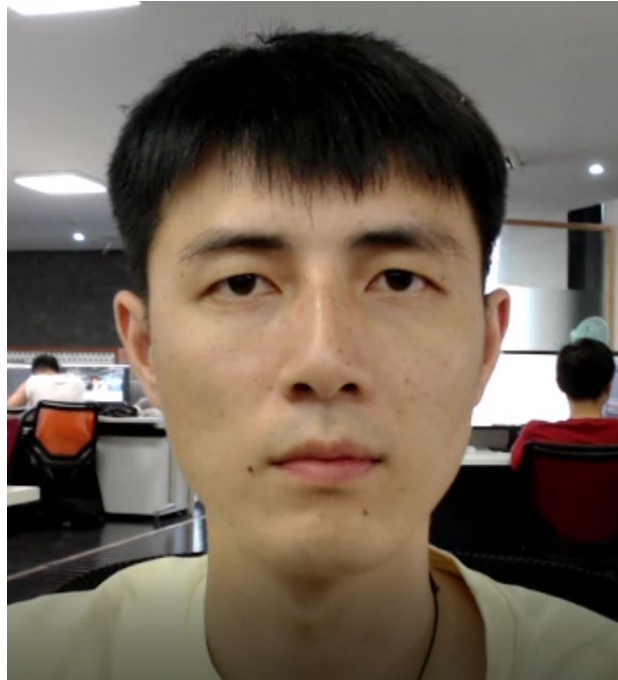
Facial Performance Capture

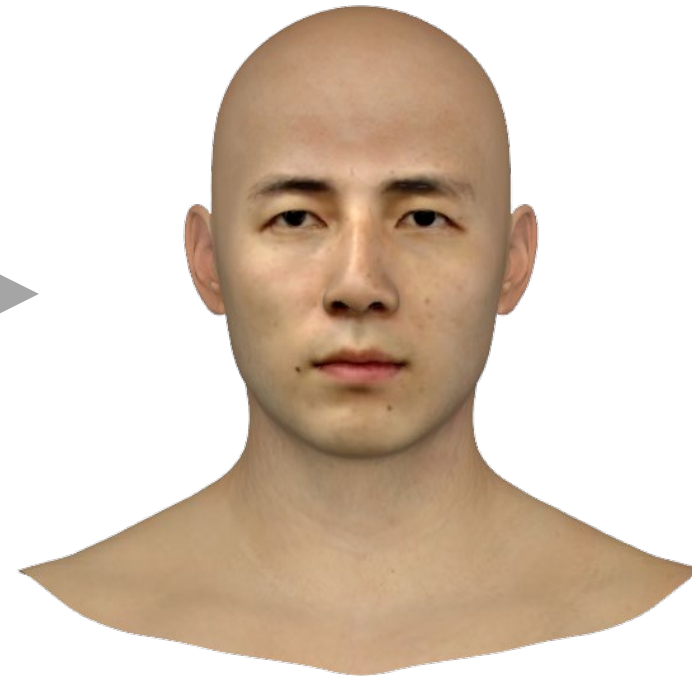# Application 1: 3D Face Reconstruction

- Single view

- Multi-view
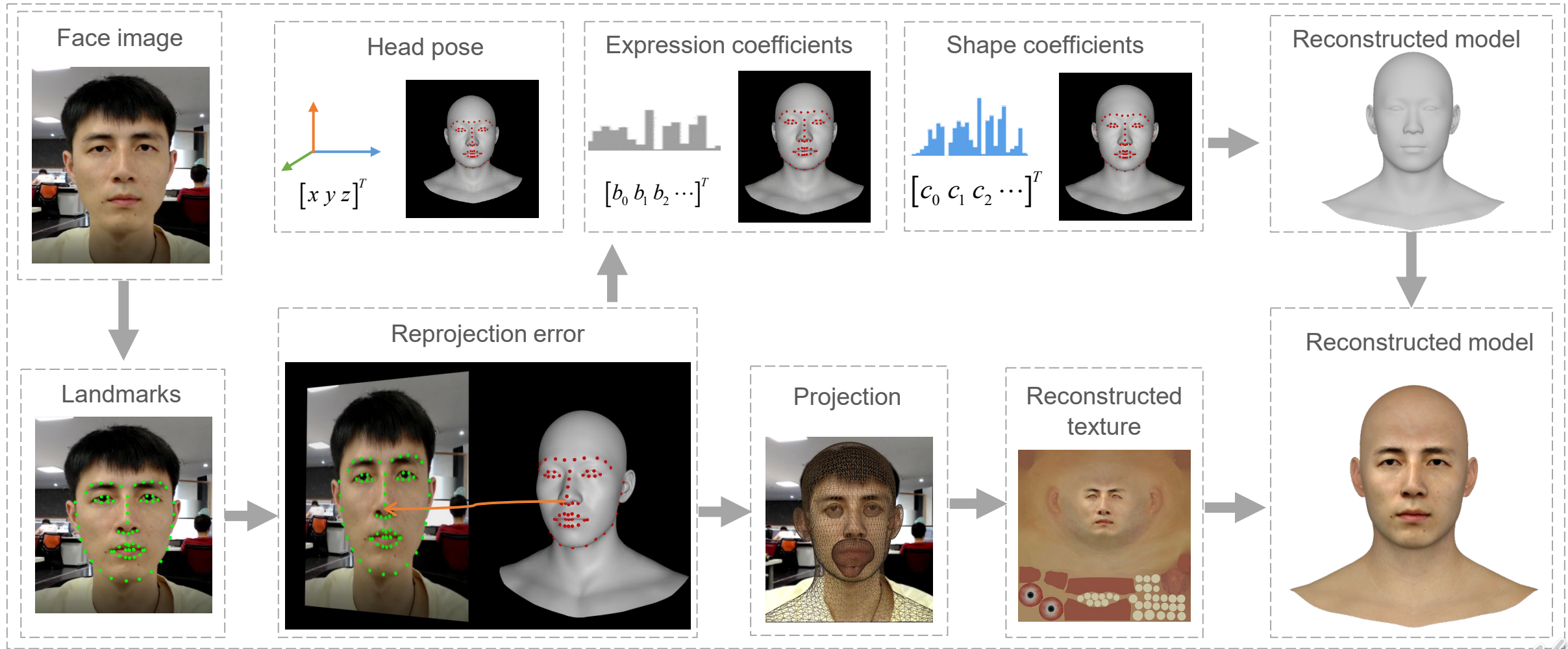
3D Face Reconstruction: Single view

Face image

3D face model

3D Face Reconstruction: Single view

Face image

Head pose

$[x\ y\ z]^T$

Expression coefficients

$[b_0\ b_1\ b_2 \cdots]^T$

Shape coefficients

$[c_0\ c_1\ c_2 \cdots]^T$

Reconstructed model

Landmarks

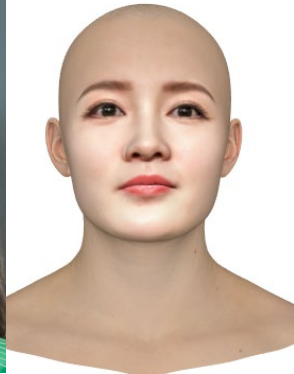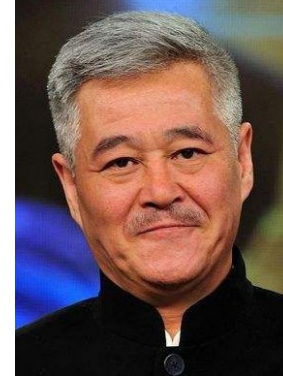Reprojection error

Projection

Reconstructed texture
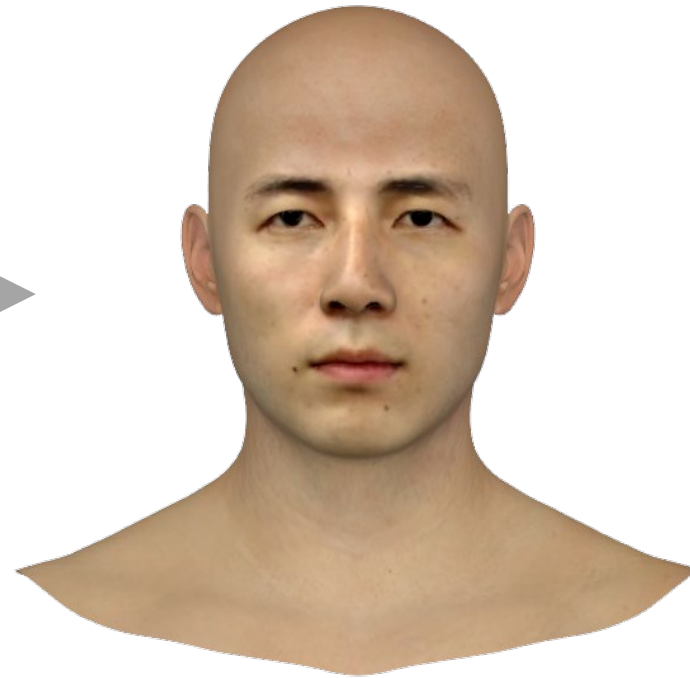
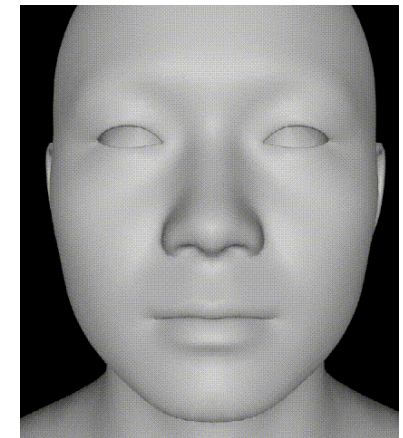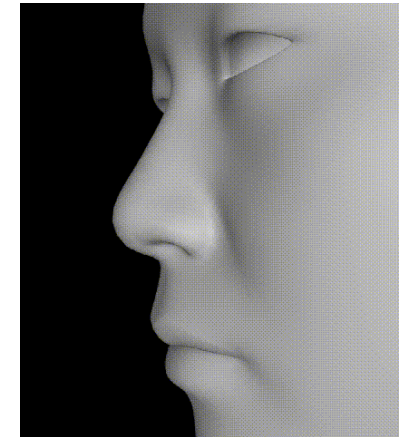Reconstructed model

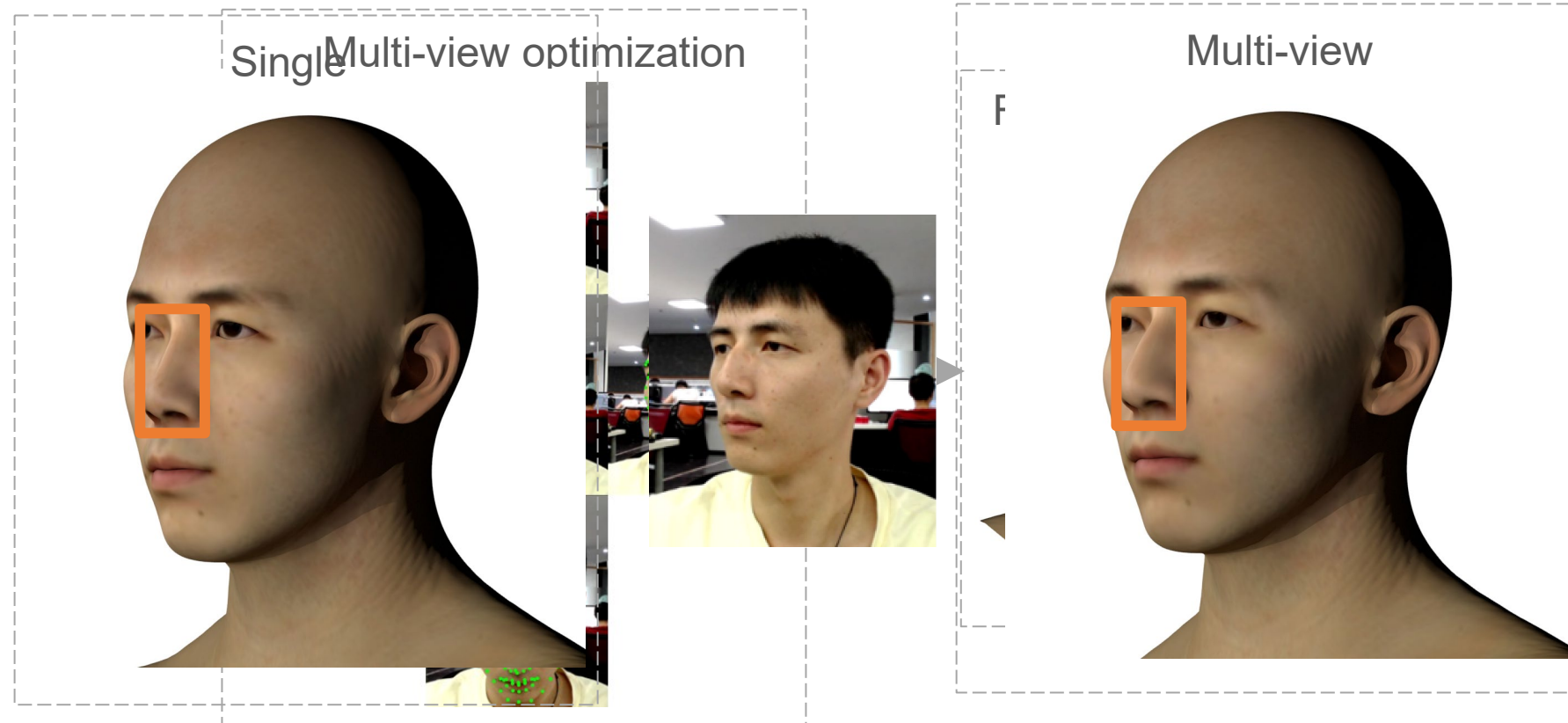# 3D Face Reconstruction: Single view

3D Face Reconstruction: Single view

Face image

3D face model

3D Face Reconstruction: Multi-view
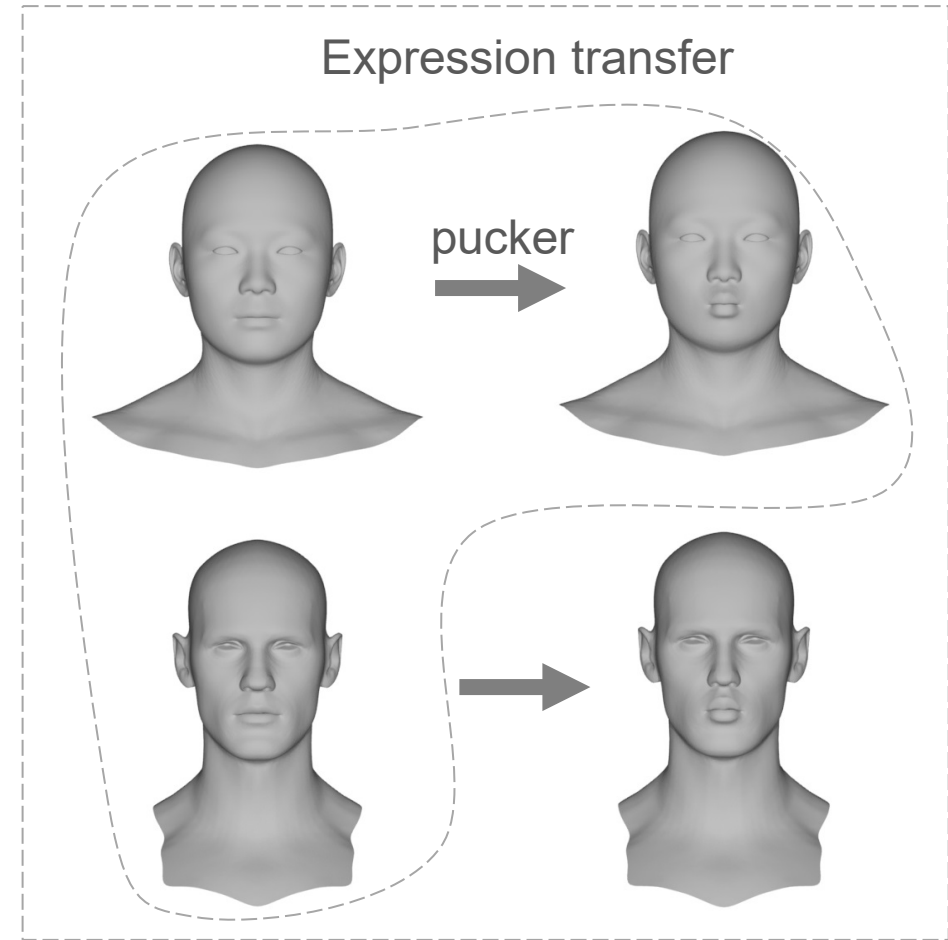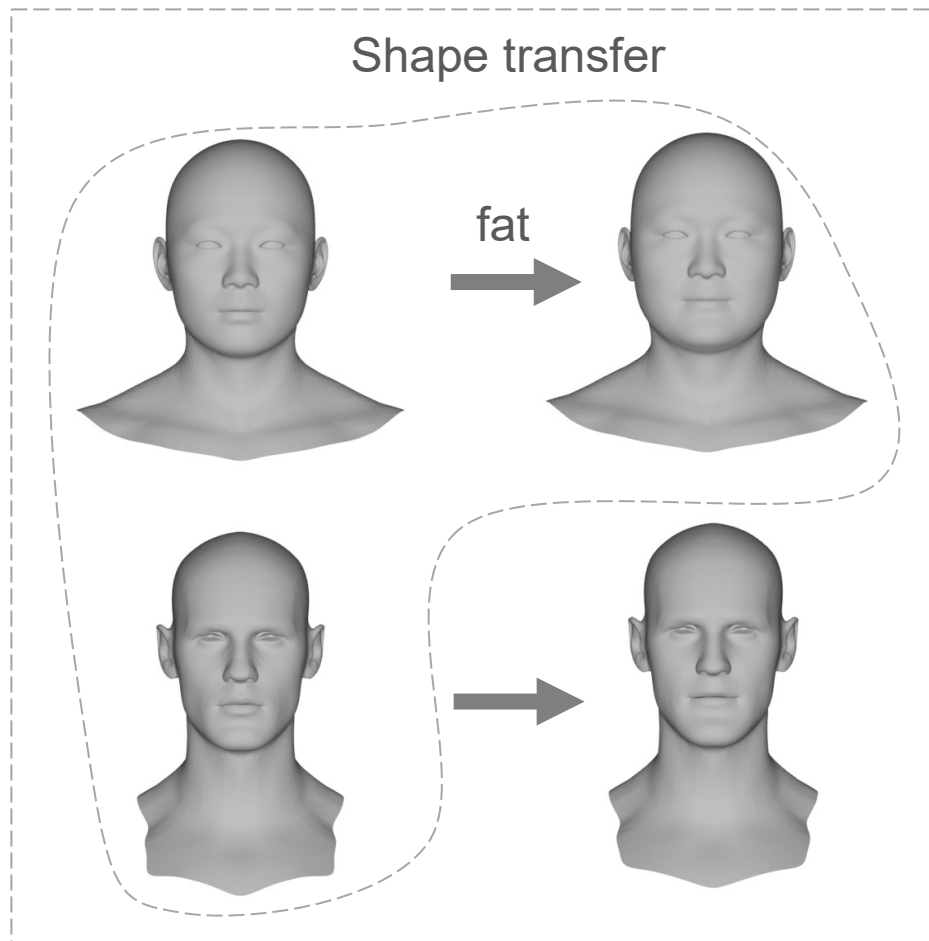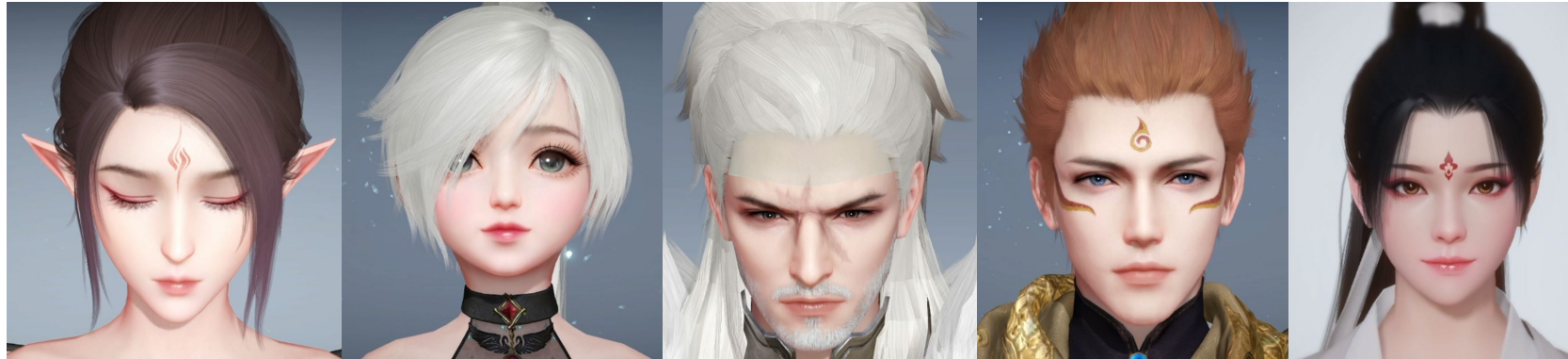

Single

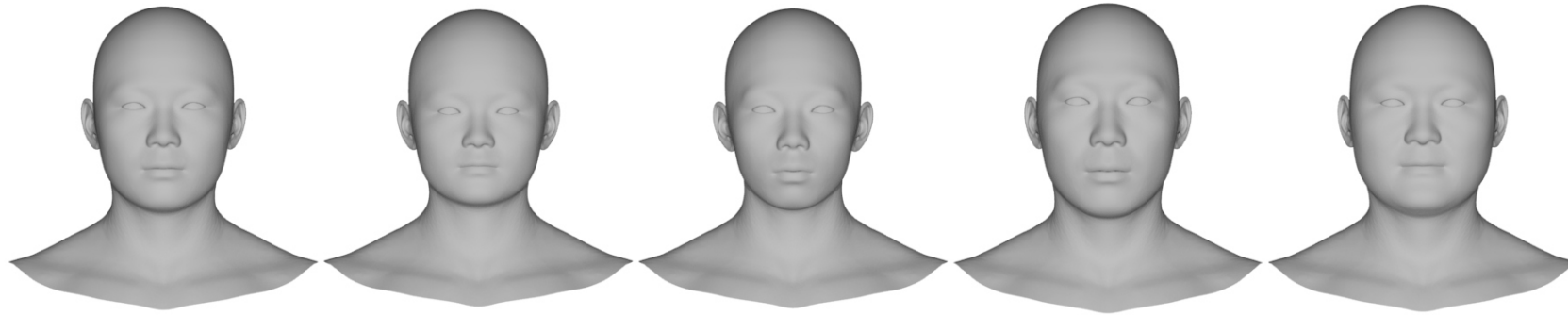Multi-view optimization

Multi-view

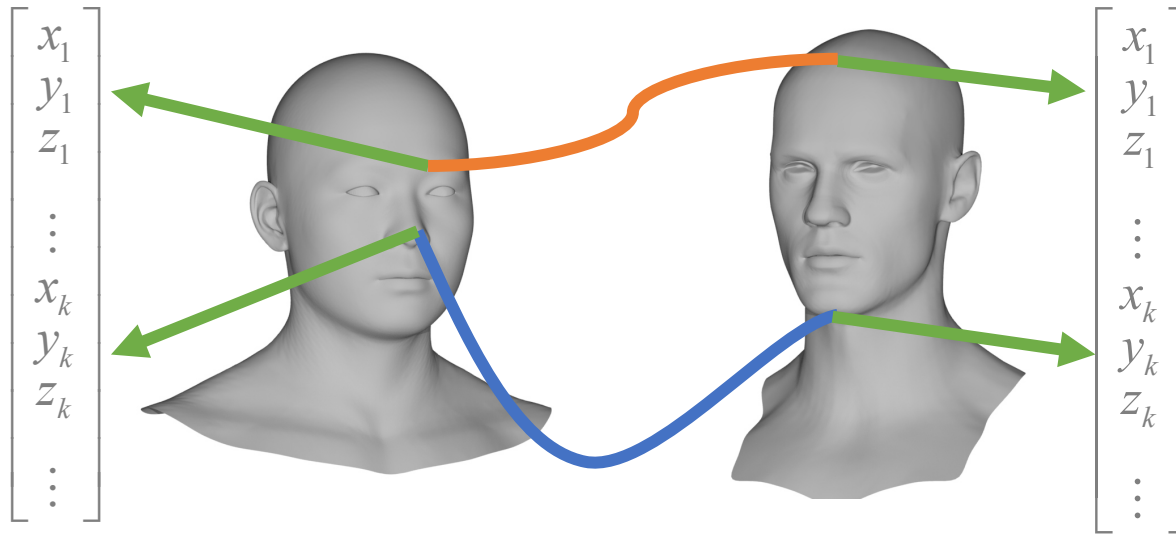# Application 2: Shape & Expression Transfer

Shape & Expression Transfer

Shape transfer

fat

Expression transfer

pucker

Shape & Expression Transfer

Inconsistent topology
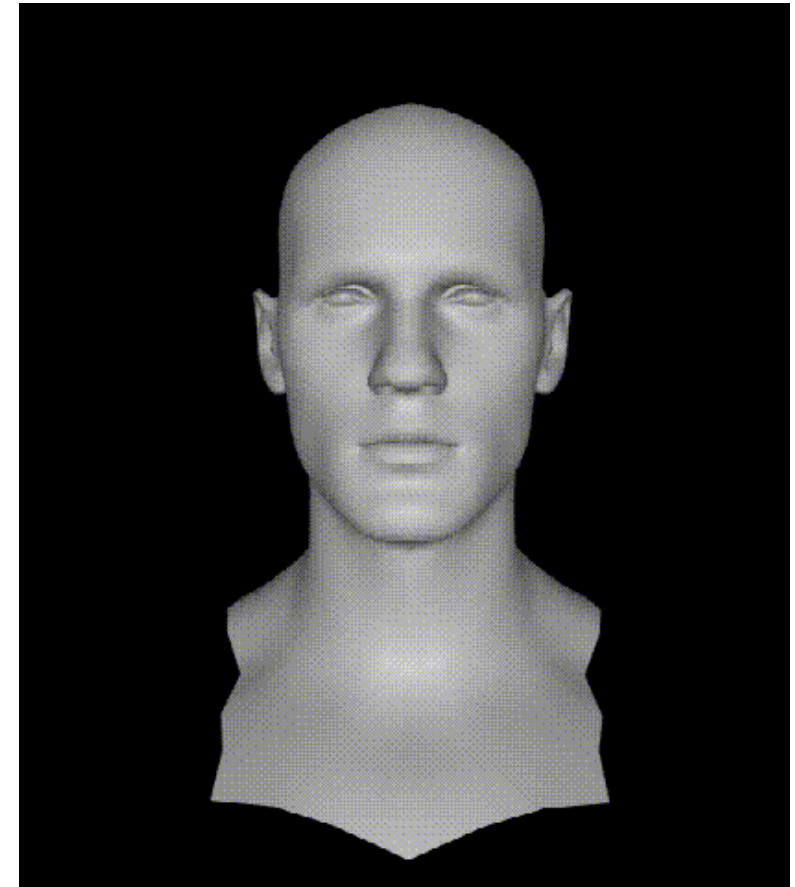
Shape & Expression Transfer

$$\begin{bmatrix} x_1 \\ y_1 \\ z_1 \\ \vdots \\ x_k \\ y_k \\ z_k \\ \vdots \end{bmatrix}$$

$$\begin{bmatrix} x_1 \\ y_1 \\ z_1 \\ \vdots \\ x_k \\ y_k \\ z_k \\ \vdots \end{bmatrix}$$

Inconsistent topology

Shape & Expression Transfer

$$\min \sum_j \left\| S_{s_j} - T_{t_j} \right\|_F^2$$

S_{S_i}

T_{T_i}

Source

Target

Shape Transfer

Reference

Inputs

Expression Transfer

Reference

Inputs
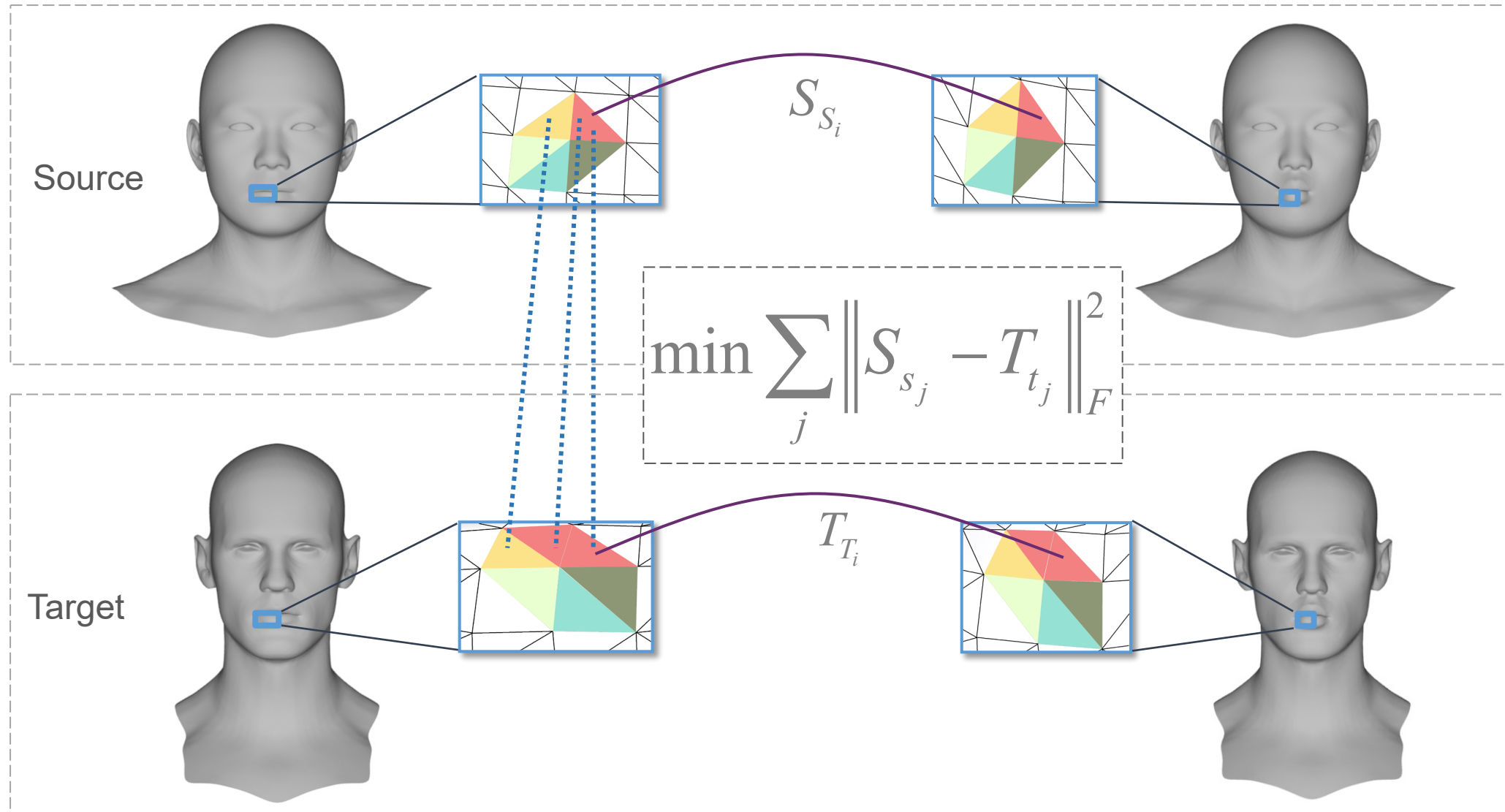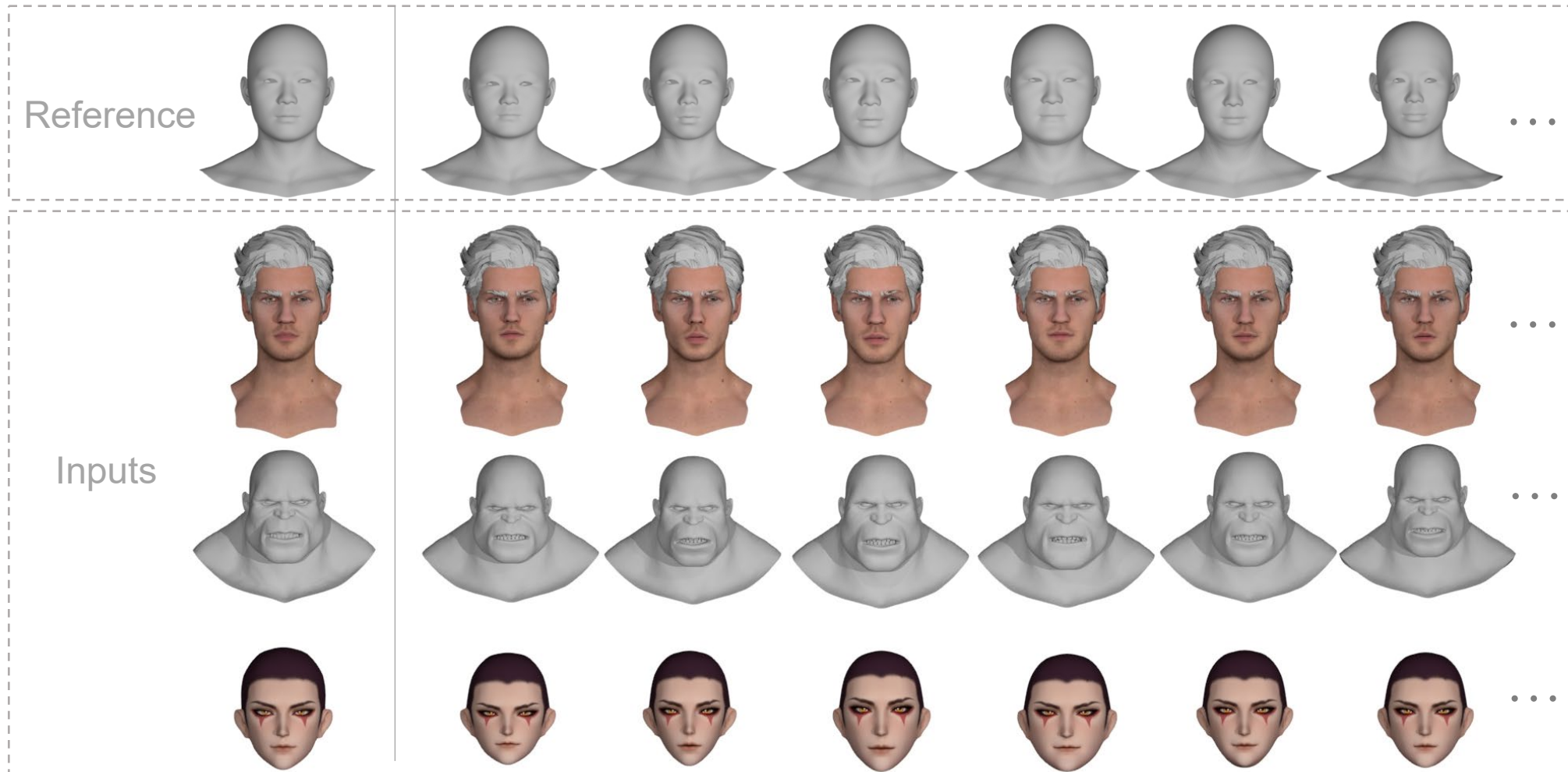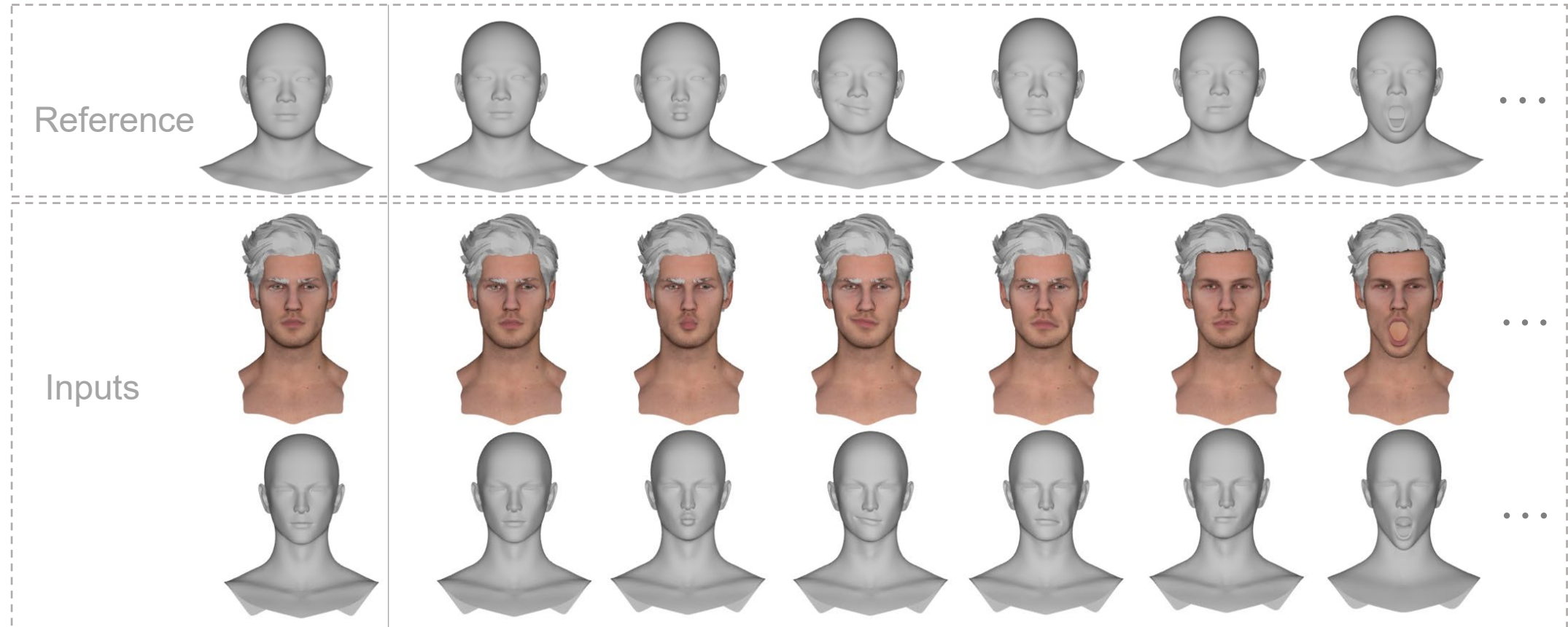
Application 3: Facial Performance Capture
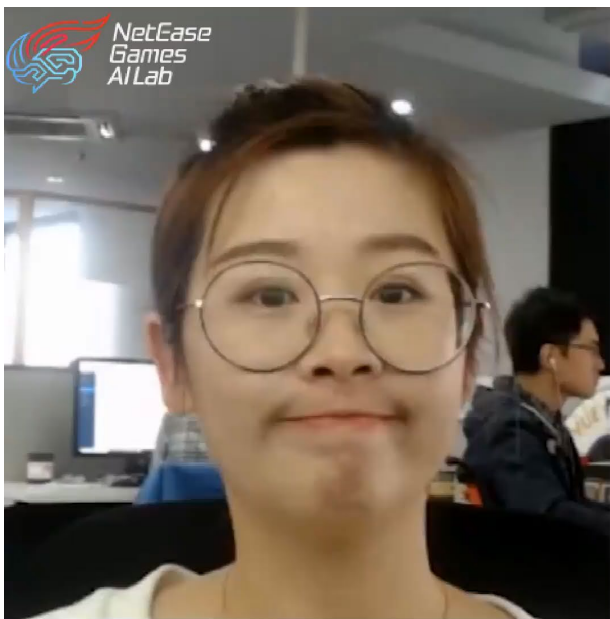
Facial Performance Capture

Video frame

Reprojection error

Head pose

$[x\ y\ z]^T$

Expression coefficients

$[b_0\ b_1\ b_2 \cdots]^T$

Expression parameters

Landmarks

Blink detection

Blink

Gaze tracking

Gaze orientation

Tongue tracking

Tongue orientation

Facial Performance Capture

Video   NetEase   Faceware   ARKit
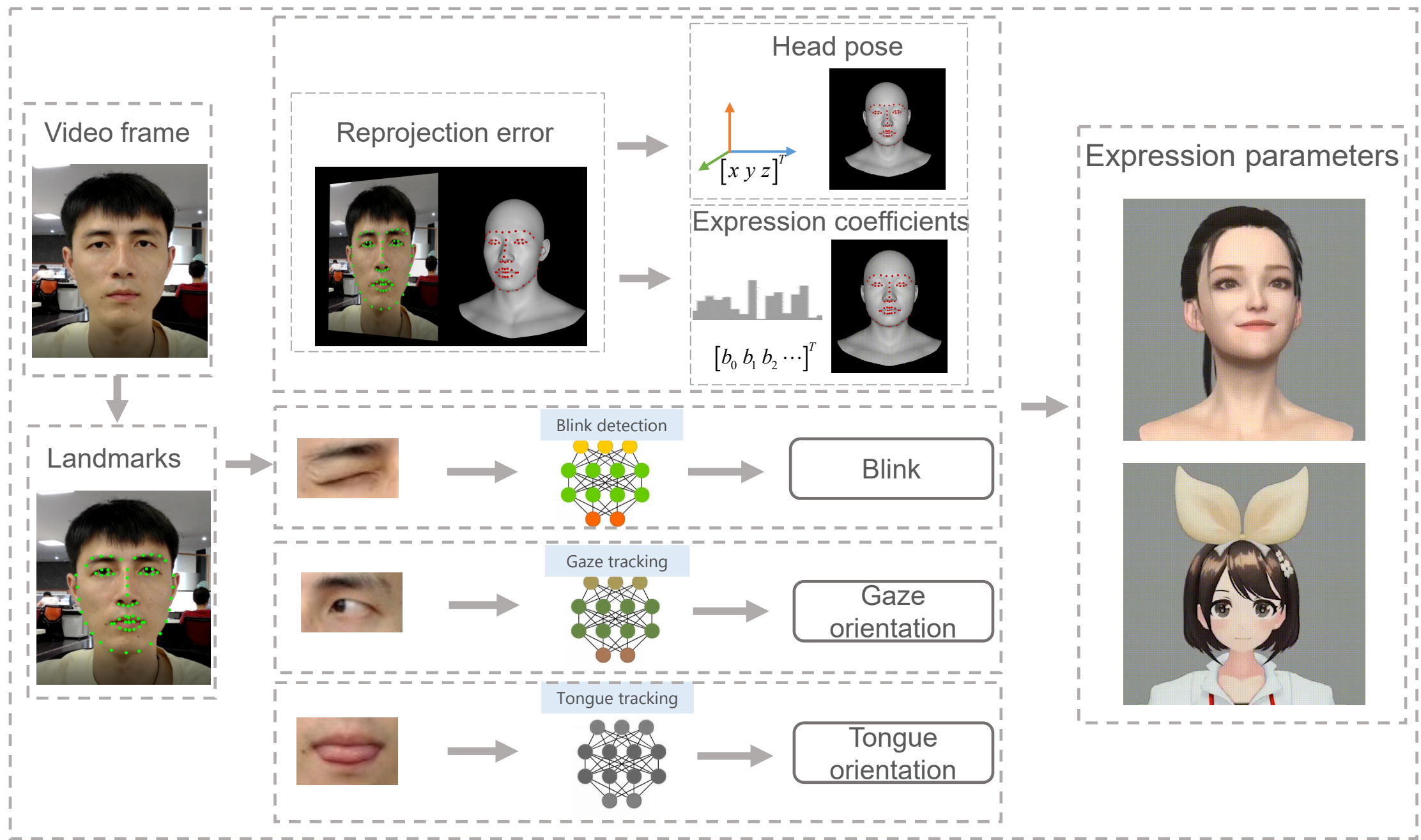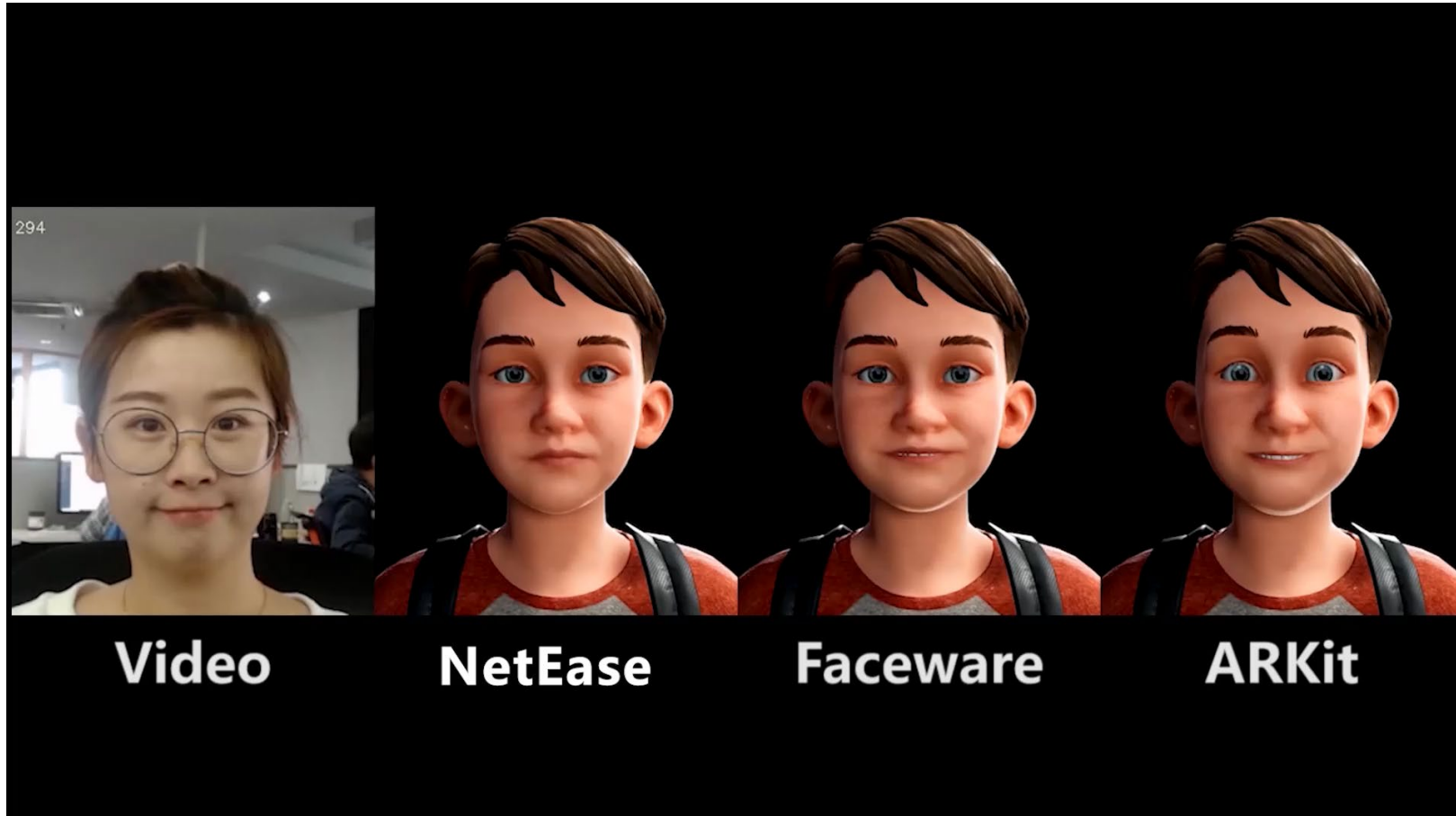
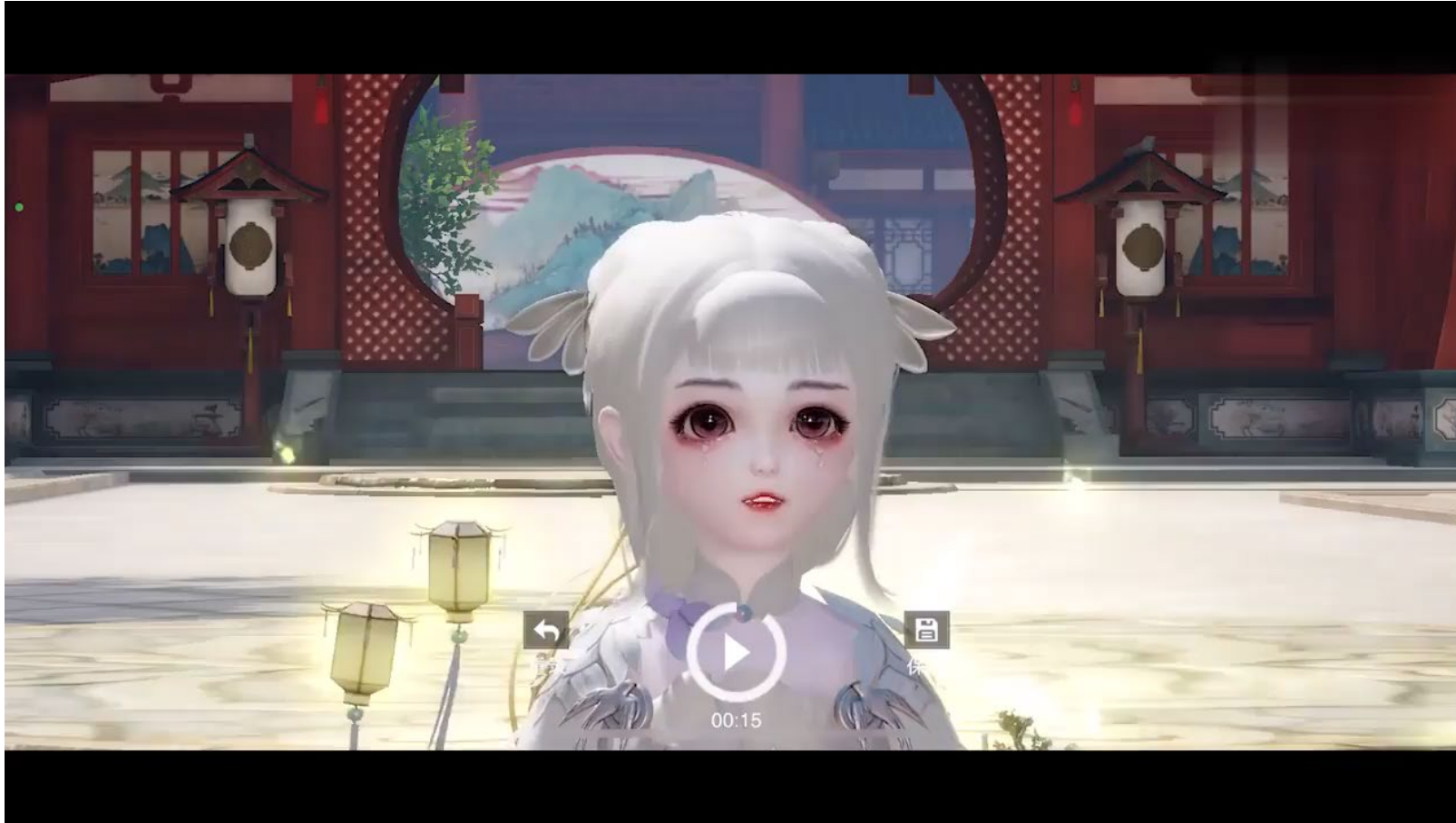# Virtual Commentator

Transfer players' expressions

Thanks