

Makeup Prior Models for 3D Facial Makeup Estimation and Applications

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Introduction

Background: 3D Morphable Model (3DMM) is essential in face-related tasks but lacks comprehensive makeup representation

Objective: To extend 3DMM with robust & efficient **makeup prior models**



Input

DECA

**Ours
(PCA)**

**Ours
(StyleGAN2)**

Contributions

Two makeup prior models:

PCA-based: highly efficient

StyleGAN2-based: detailed & accurate

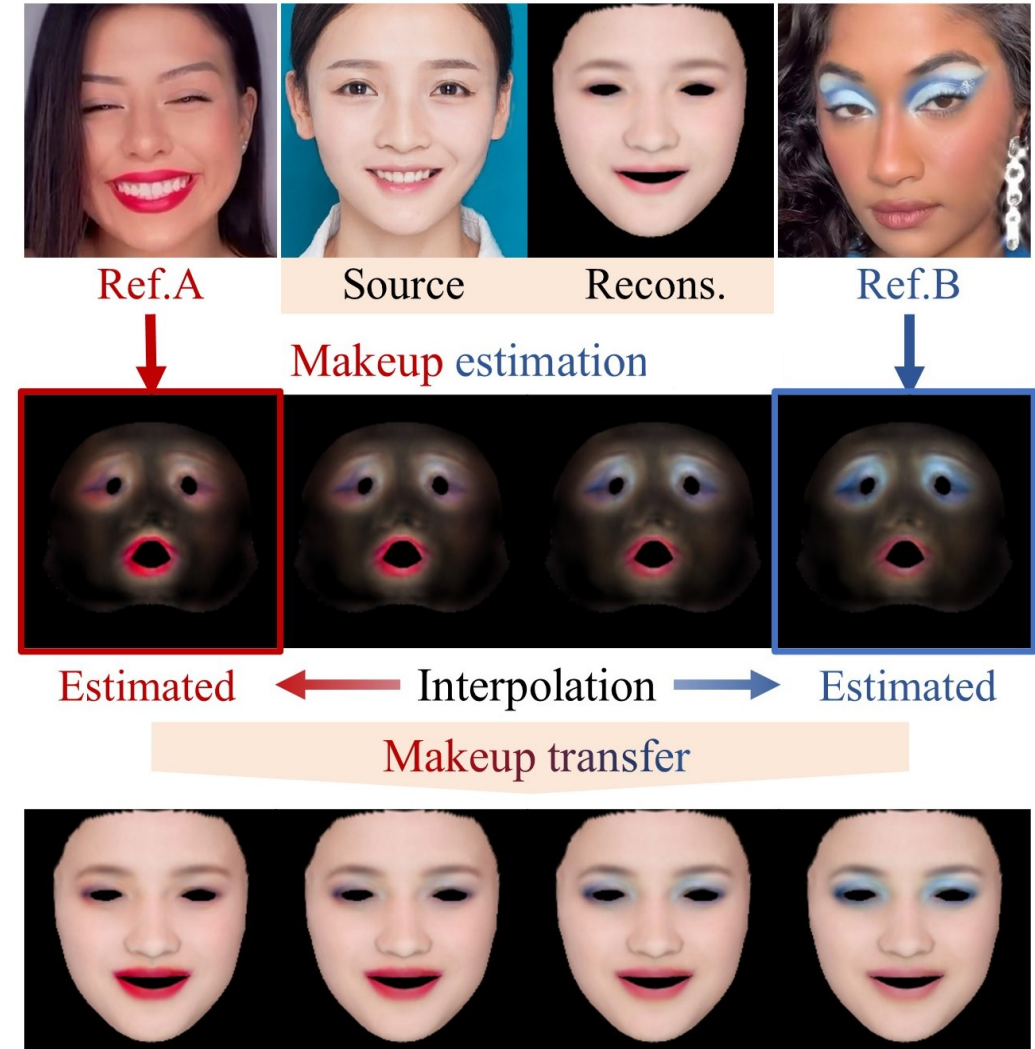
Robustness in makeup estimation and minimizes **computational time**

PCA-based: **180 times faster**

StyleGAN2-based: **3 times faster**

Applicability:

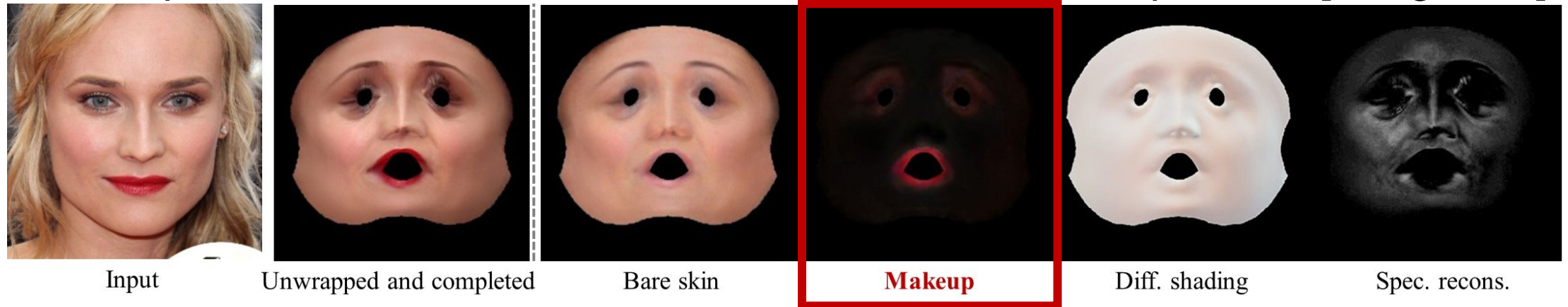
- Advanced 3D makeup face reconstruction
- user-friendly editing
- makeup transfer
- interpolation



Methodology : Makeup Prior Models

Previous Work

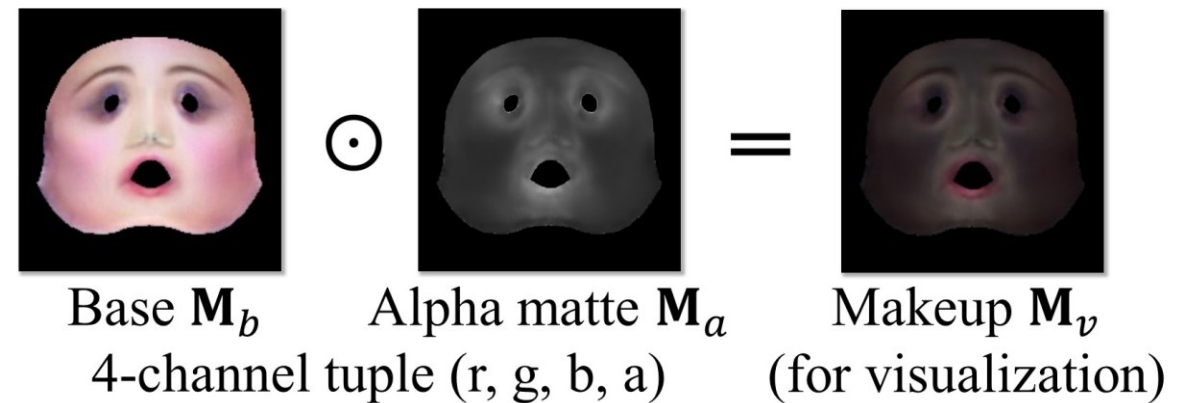
Makeup Extraction via Illumination-Aware Image Decomposition [Yang+, 23]



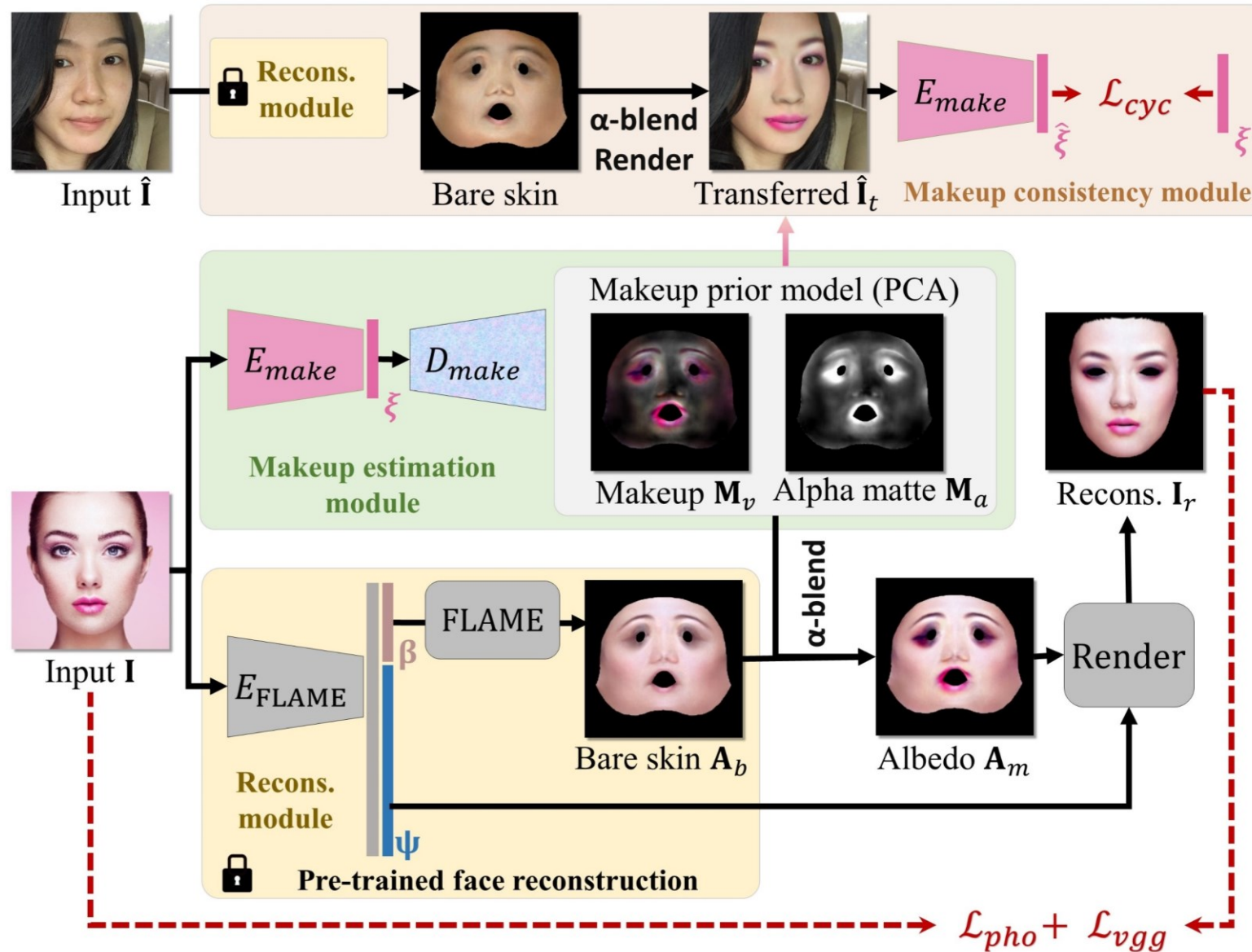
Our New Models: 4-channel models

PCA: Efficient, captures broad makeup

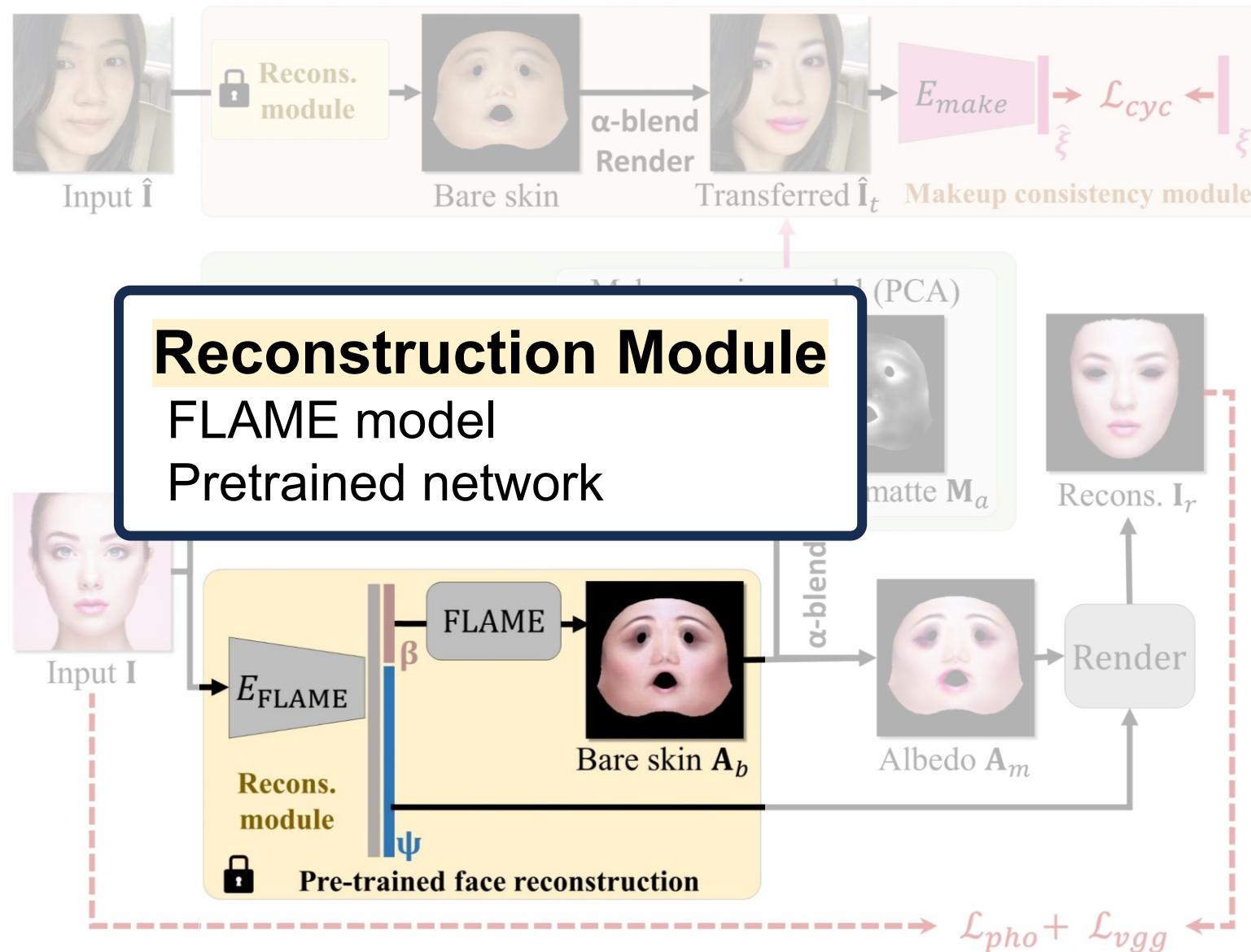
StyleGAN2: High fidelity makeup



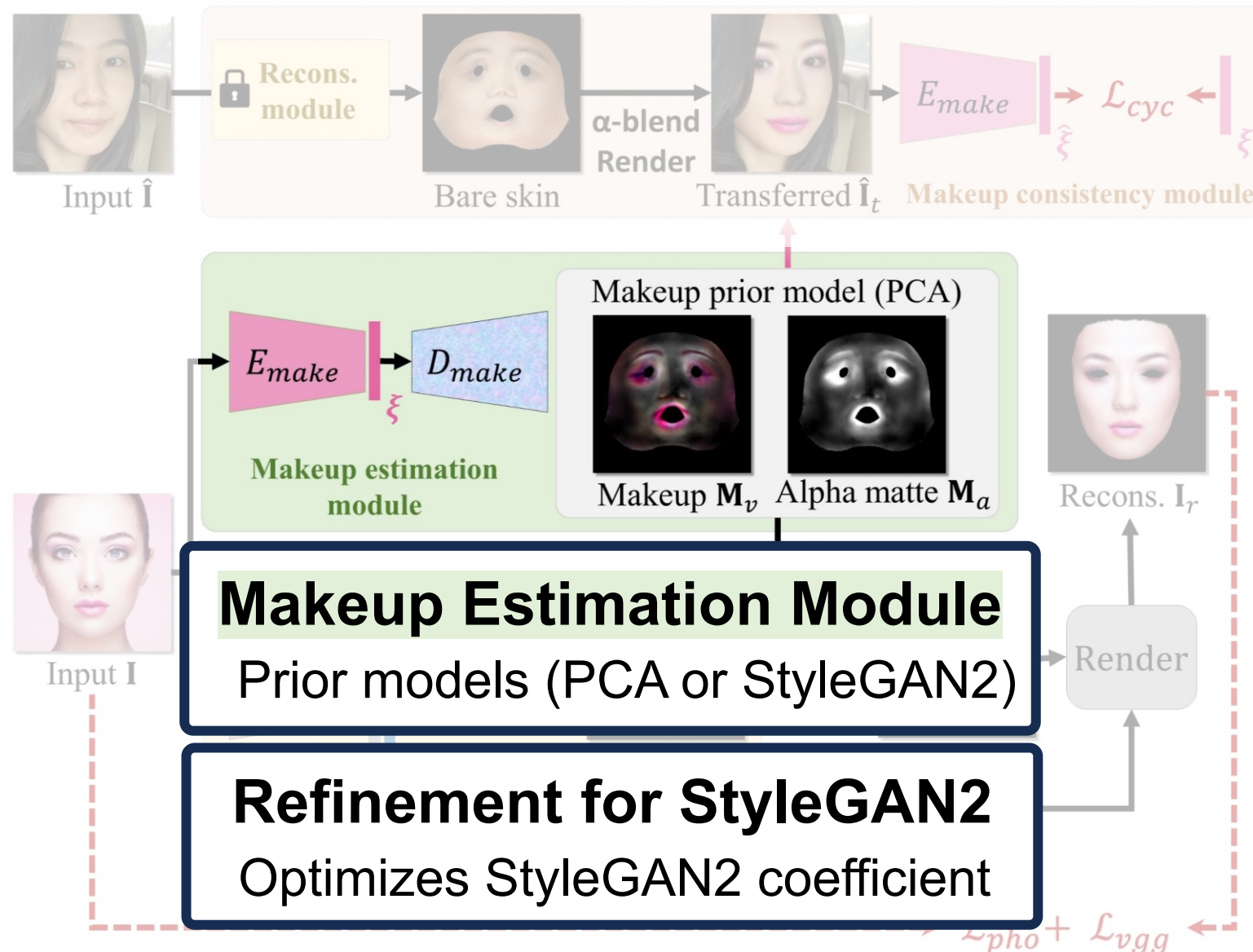
Methodology: Makeup Estimation Network



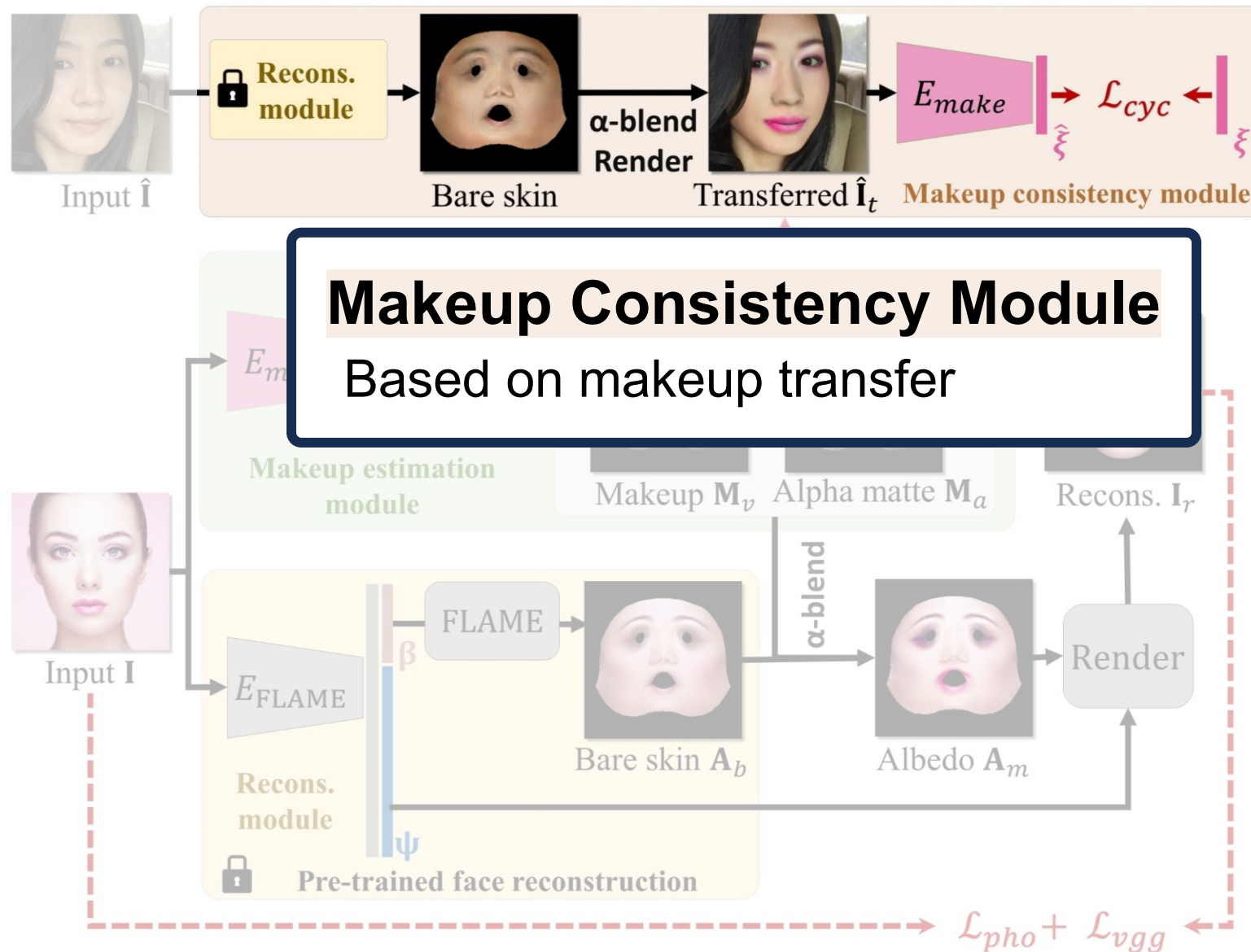
Methodology: Makeup Estimation Network



Methodology: Makeup Estimation Network



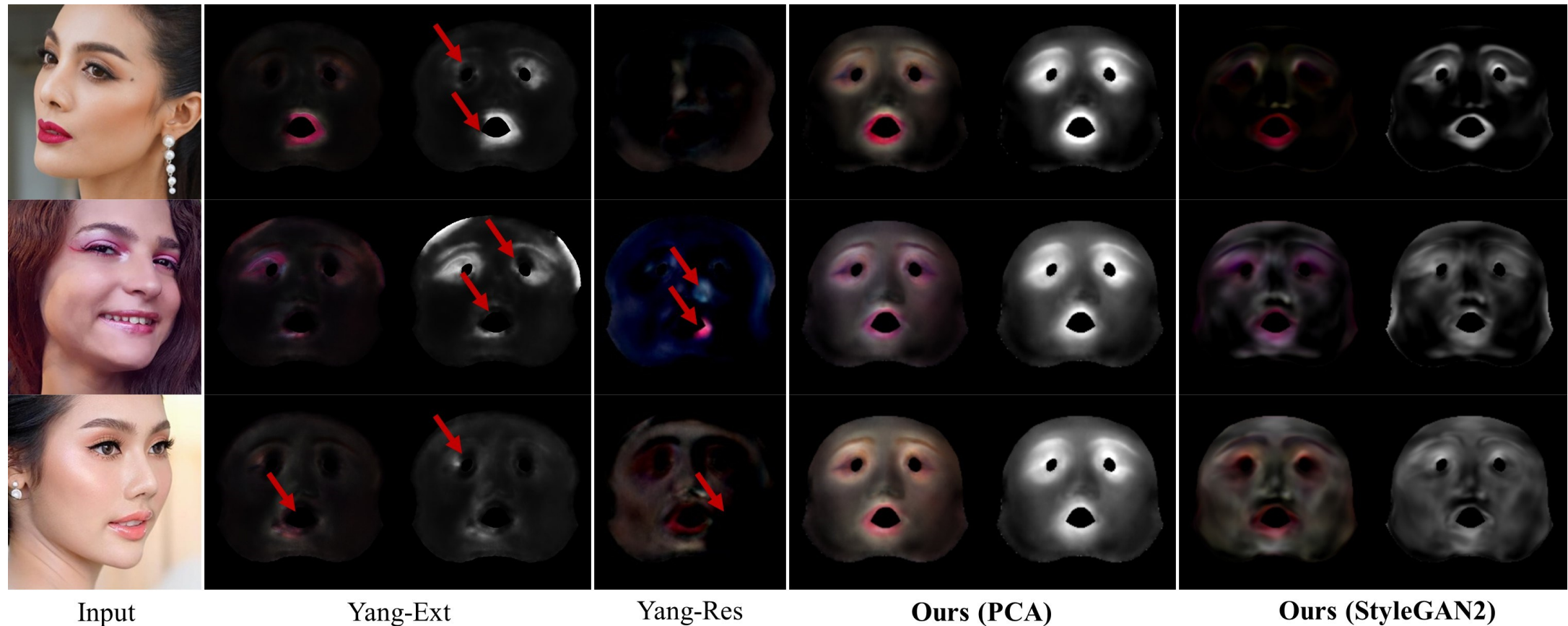
Methodology: Makeup Estimation Network



3D Makeup Estimation

Robustness and accuracy in handling **self-occluded** faces

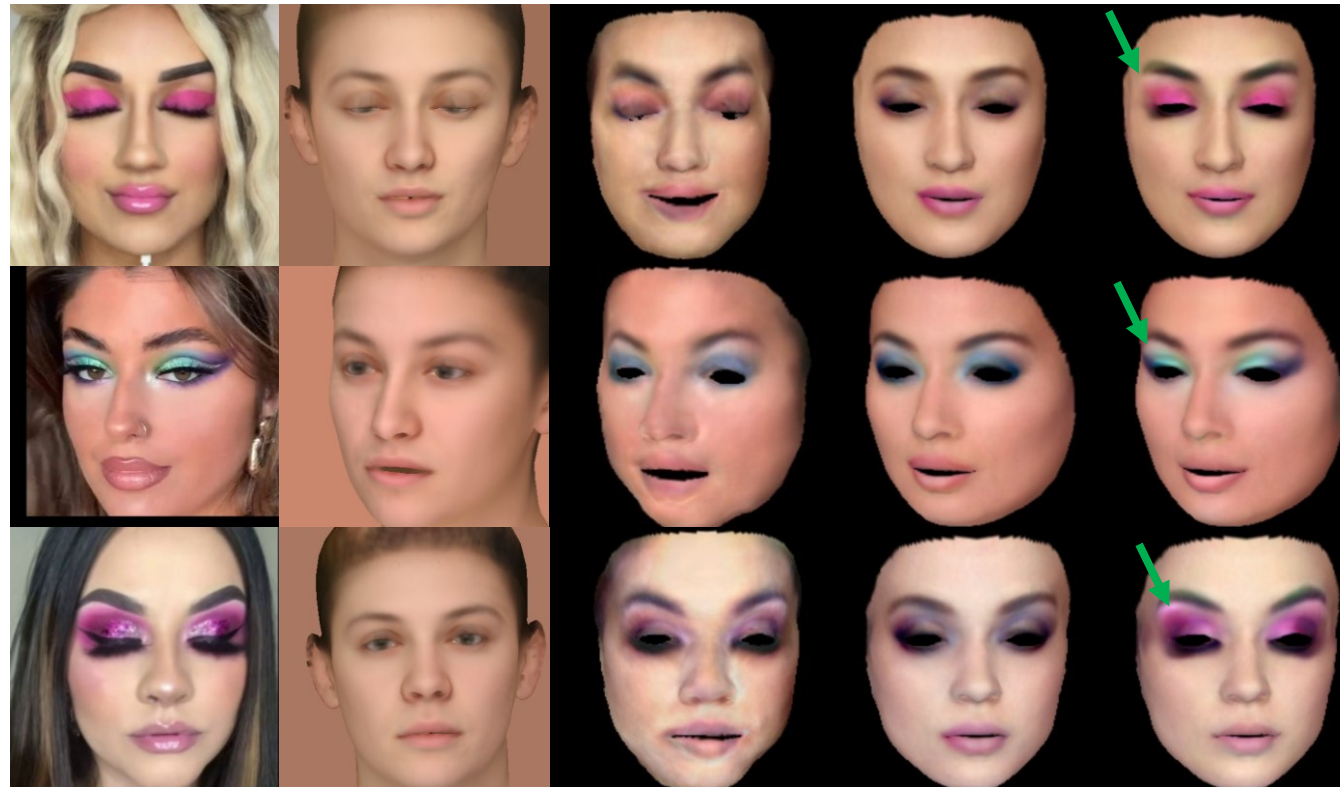
Reduced artifacts, particularly preserving the colors around the eyes and lips



3D Face Reconstruction

PCA model efficiently restores broad makeup colors

StyleGAN2 model precisely recovers complex makeup features, such as gradient eyeshadow



Input

DECA

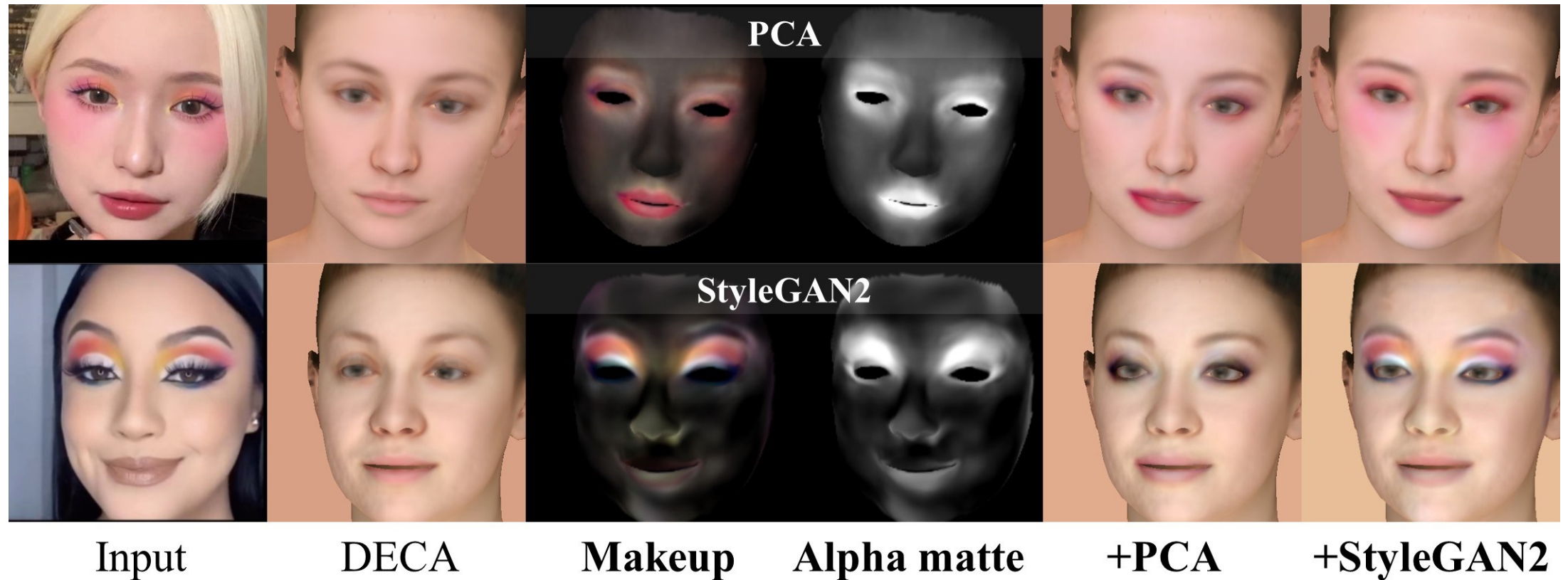
Yang-Res

Ours
(PCA)

Ours
(StyleGAN2)

3D Face Reconstruction

Incorporated into other model-based 3D face reconstruction methods



Quantitative Evaluation

Improved performance of 3D face reconstruction

PCA can be enhanced

StyleGAN2 achieves the highest accuracy

Bold: best results; Underlined: second-best

Method	Histogram matching		Wild			BeautyFace				
	HM(eyes)↓	HM(lips)↓	RMSE↓	SSIM↑	LPIPS↓	HM(eyes)↓	HM(lips)↓	RMSE↓	SSIM↑	LPIPS↓
DECA	0.0048	0.0088	0.0876	0.3651	0.0871	0.0043	0.0106	0.0636	0.4002	0.0840
DECA* (PCA)	<u>0.0045</u>	<u>0.0081</u>	<u>0.0871</u>	0.3683	<u>0.0822</u>	<u>0.0041</u>	<u>0.0081</u>	<u>0.0595</u>	<u>0.4041</u>	<u>0.0779</u>
DECA* (StyleGAN2)	0.0044	0.0076	0.0807	<u>0.3678</u>	0.0798	0.0039	0.0077	0.0568	0.4042	0.0747
<i>FRN</i>	0.0045	0.0093	0.0667	0.5940	0.0750	0.0037	0.0102	<u>0.0666</u>	<u>0.5034</u>	0.0745
Ours (PCA)	<u>0.0041</u>	<u>0.0078</u>	<u>0.0609</u>	<u>0.6111</u>	<u>0.0681</u>	<u>0.0035</u>	<u>0.0078</u>	0.0690	0.5013	<u>0.0733</u>
Ours (StyleGAN2)	0.0036	0.0073	0.0517	0.6240	0.0608	0.0031	0.0068	0.0650	0.5134	0.0673

DECA + our makeup prior models

3D Makeup Interpolation

Facilitates full and partial makeup interpolation

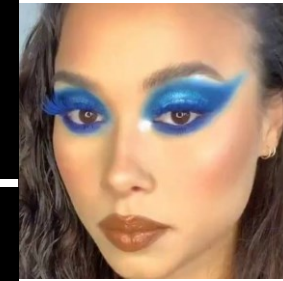
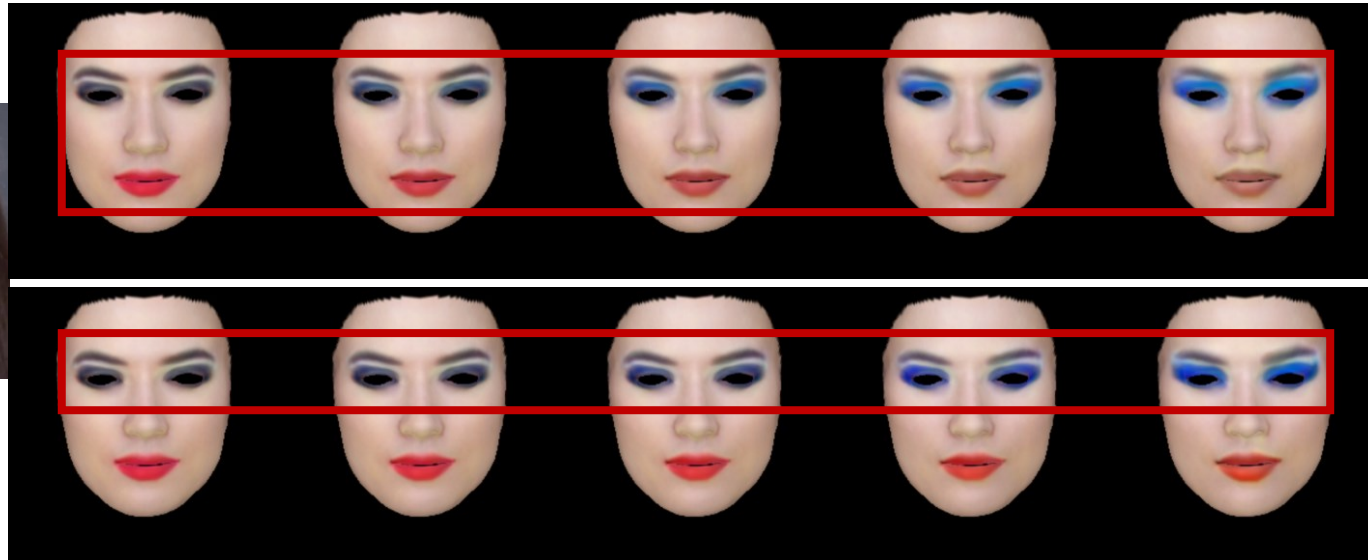
Full interpolation : blend eyeshadow and lipstick

Partial interpolation : retain lipstick and blend eyeshadow

Full makeup interpolation



Ref.A



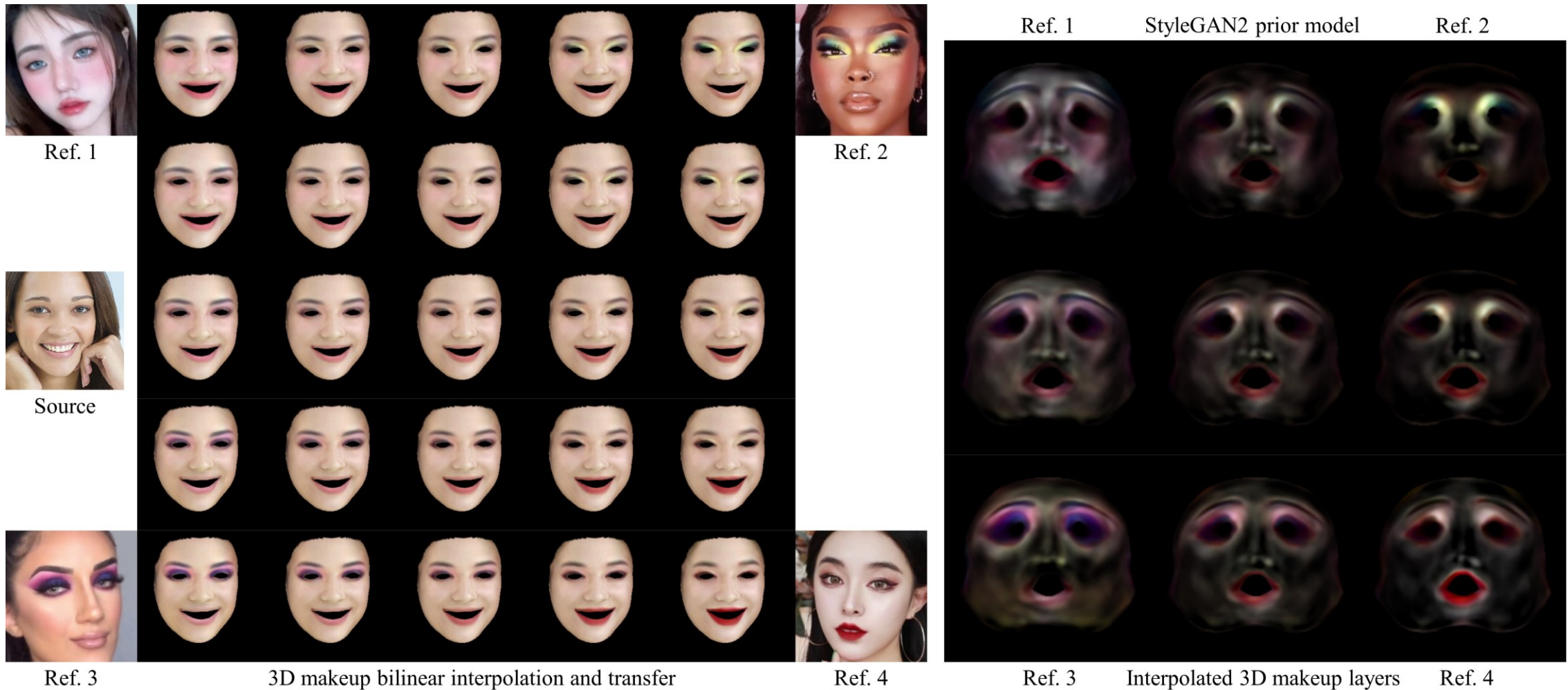
Ref.B

Partial makeup interpolation (**only eyeshadow**)

Example of StyleGAN2 makeup prior model

3D Makeup Transfer

Accurate and reliable transfer of makeup between different 3D faces



Conclusion

Efficiency and Accuracy: PCA-based model is highly efficient;
StyleGAN2-based model excels in detail and accuracy

Robustness: Makeup consistency module enhances robustness

Future Work: Explore decoupling capabilities of StyleGAN2 for advanced
makeup manipulation

Thank you!

