CoordGAN: Self-Supervised Dense Correspondences Emerge from GANs
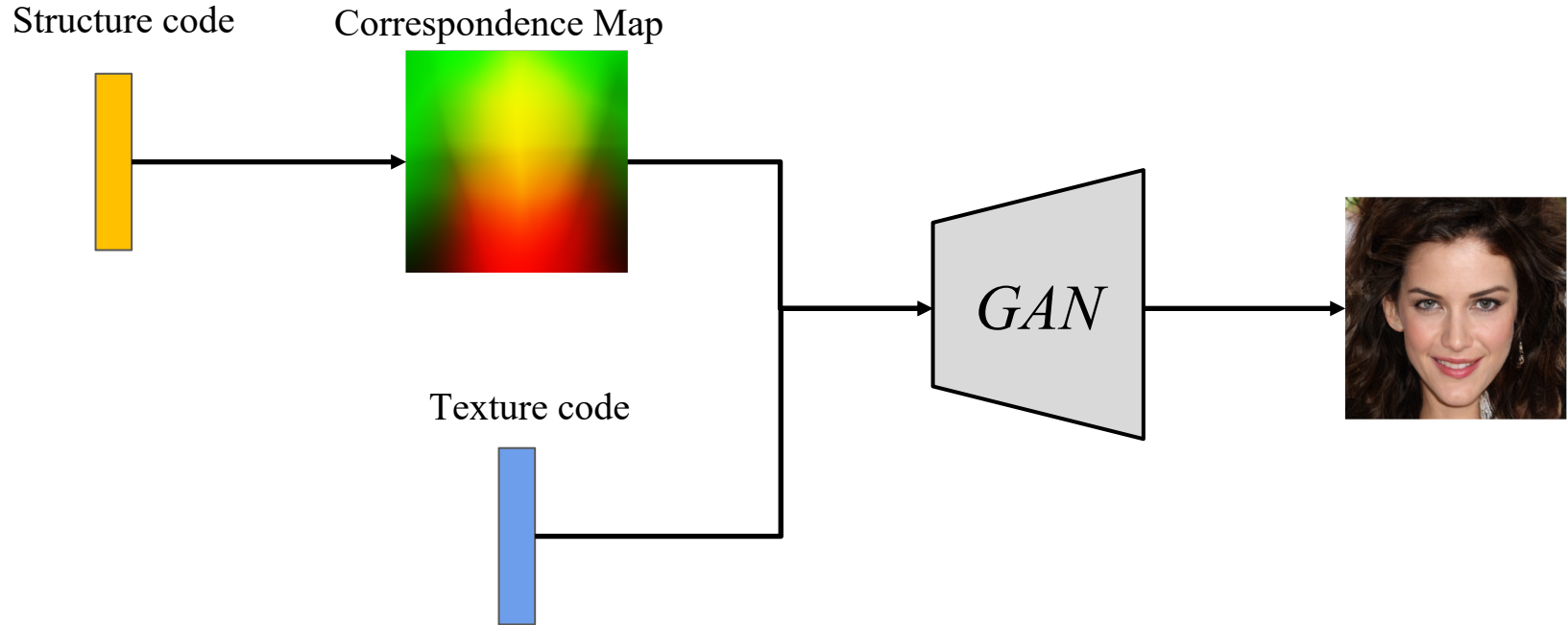
(CVPR 2022)

Jiteng Mu[1]*, Shalini De Mello[2], Zhiding Yu[2], Nuno Vasconcelos[1], Xiaolong Wang[1], Jan Kautz[2] , Sifei Liu[2]
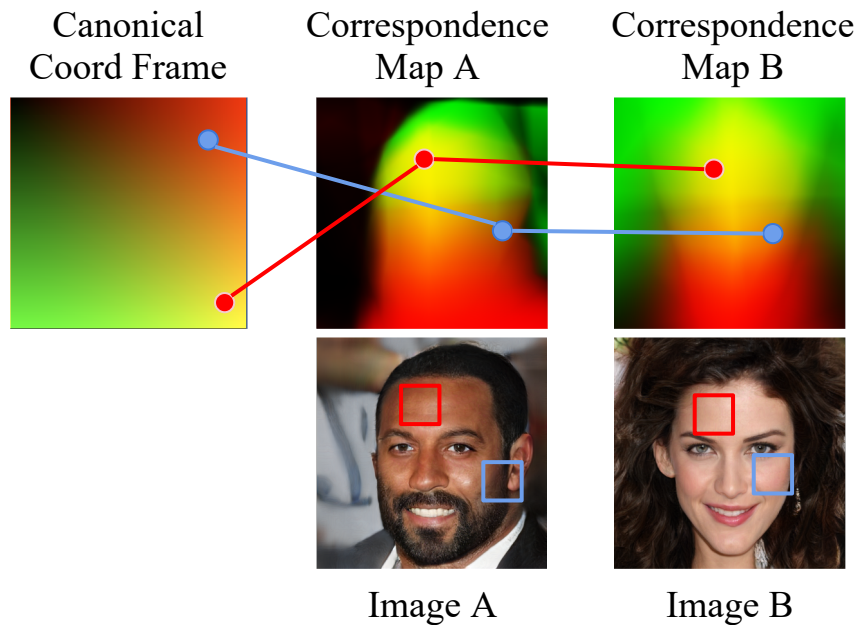
[1]UCSD, [2]Nvidia
(* Work done while an intern at Nvidia)

Highlight: Disentanglement

An image is generated by combining
a correspondence map (structure) and a texture code.
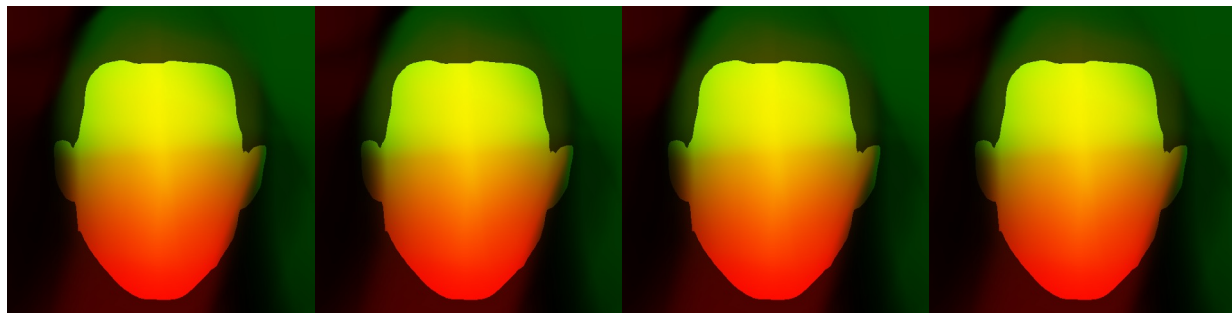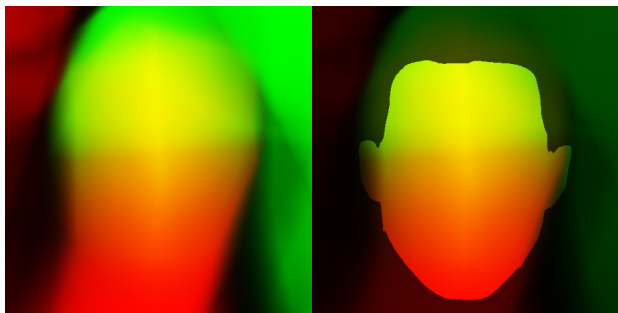
Highlight: Coordinate Space

A coordinate space is introduced to model correspondence.
Coordinates are color-coded for visualization.

Identity-preserved Texture Swapping.

Correspondence Map

Generated Images
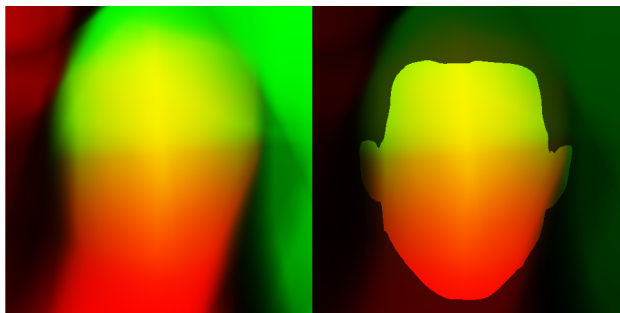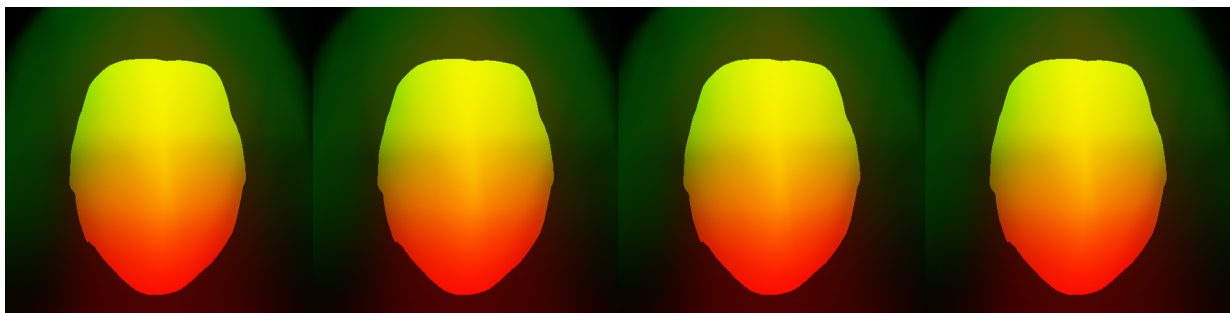(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
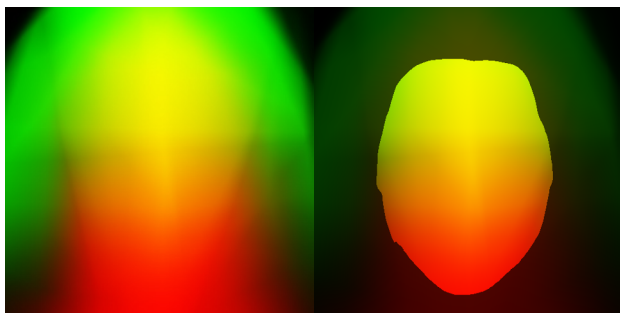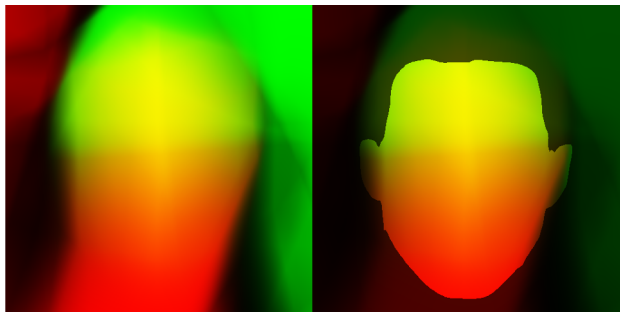(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
(Each row: same structure; Each column: same texture)
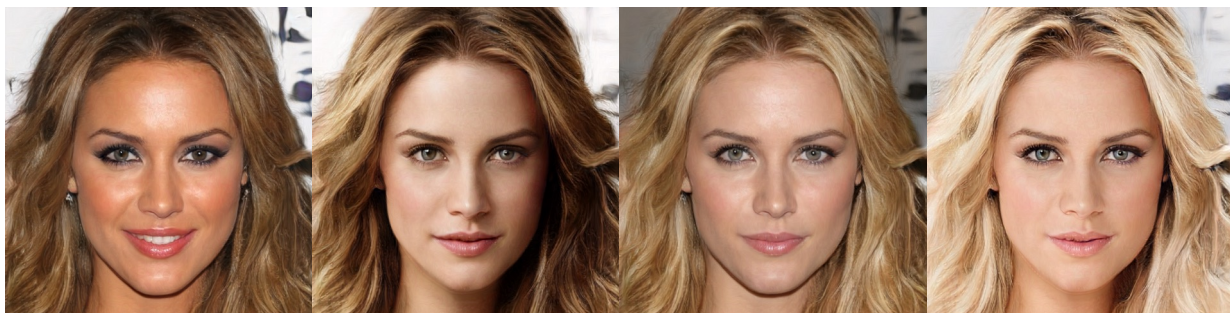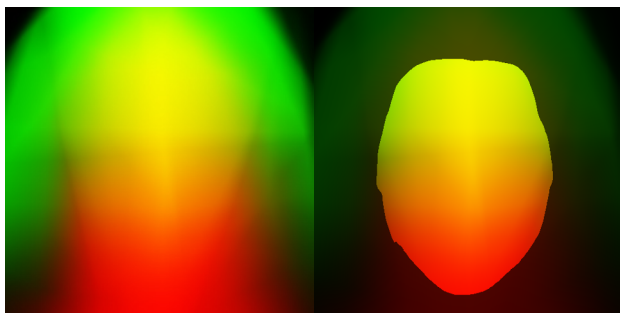
CelebAMask-HQ

Correspondence Map

Generated Images
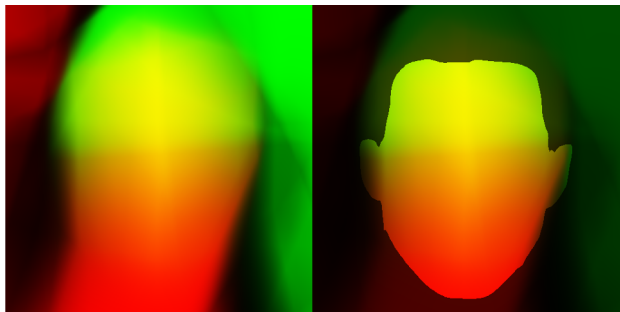(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
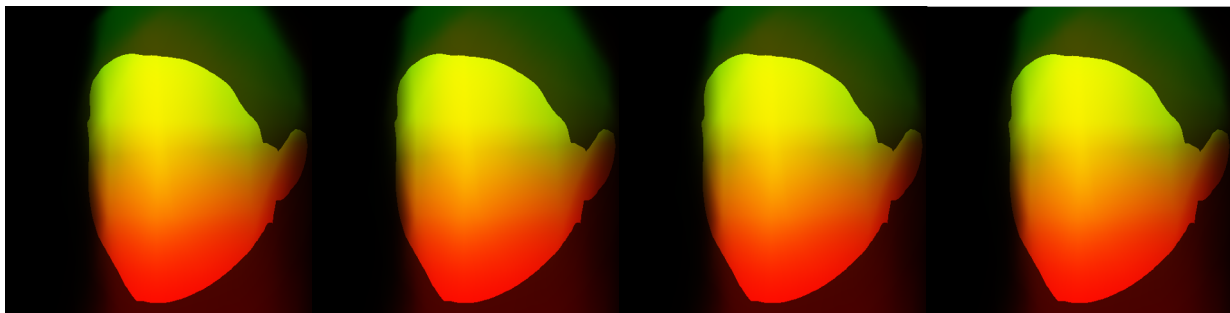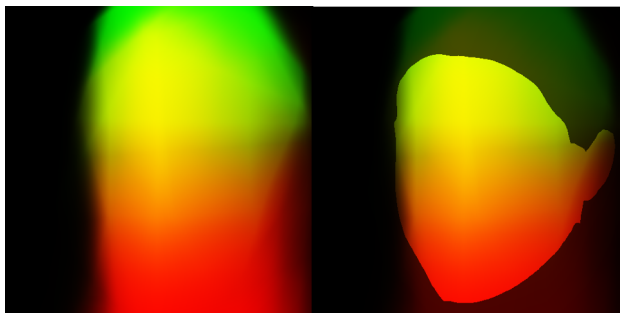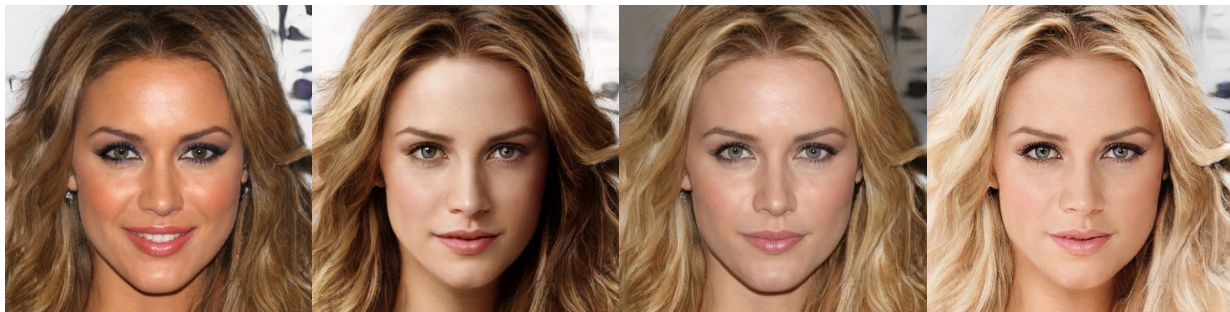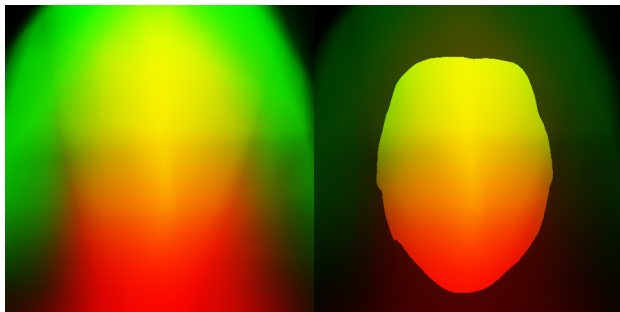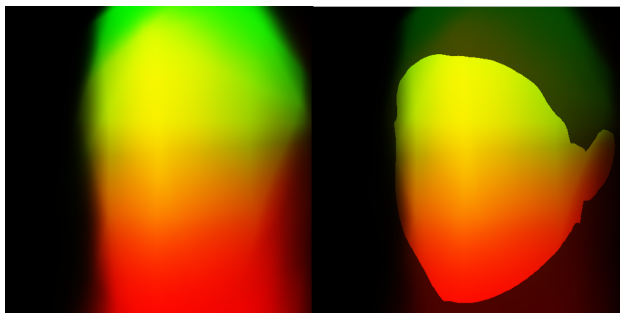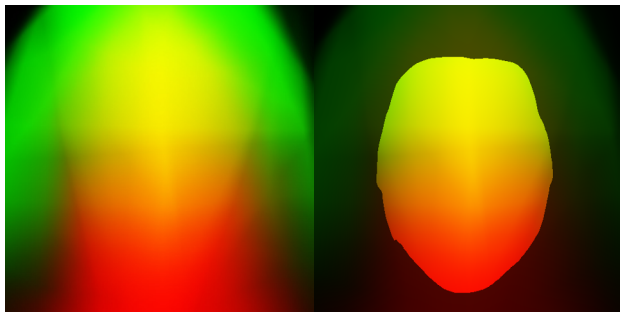(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Correspondence Map

Generated Images
(Each row: same structure; Each column: same texture)

CelebAMask-HQ

Application in other image domains.

Structure

Texture

Generated real images.

Structure
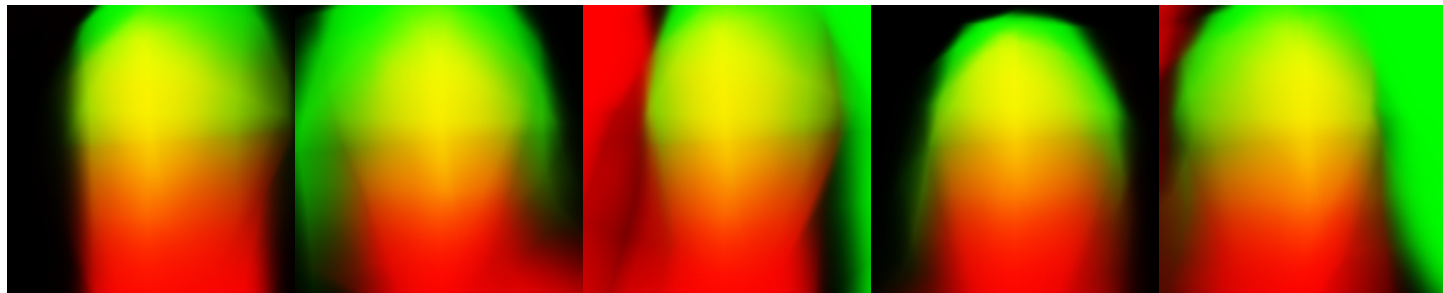
Texture

Corresponding correspondence maps.

Structure

Texture
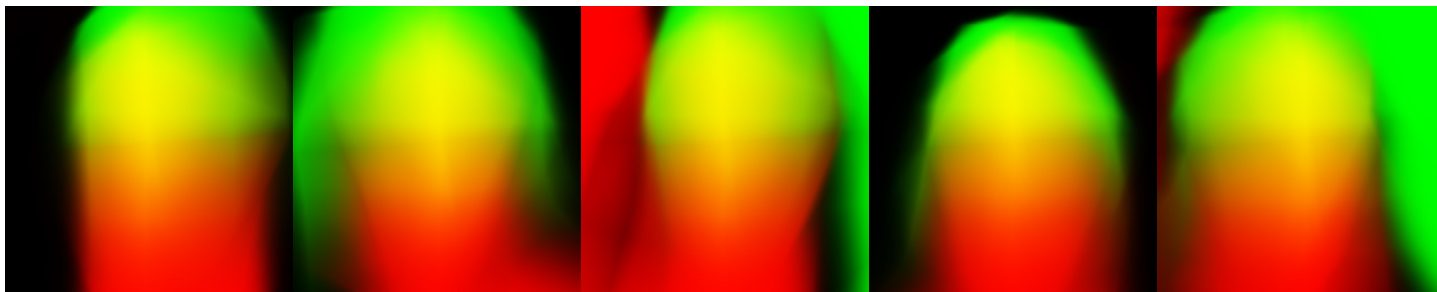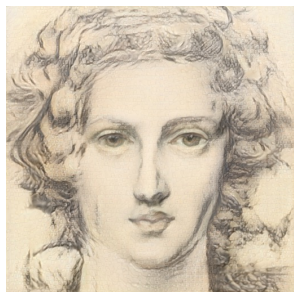
Apply Textures learned from art images.

Structure

Texture

Apply Textures learned from art images.
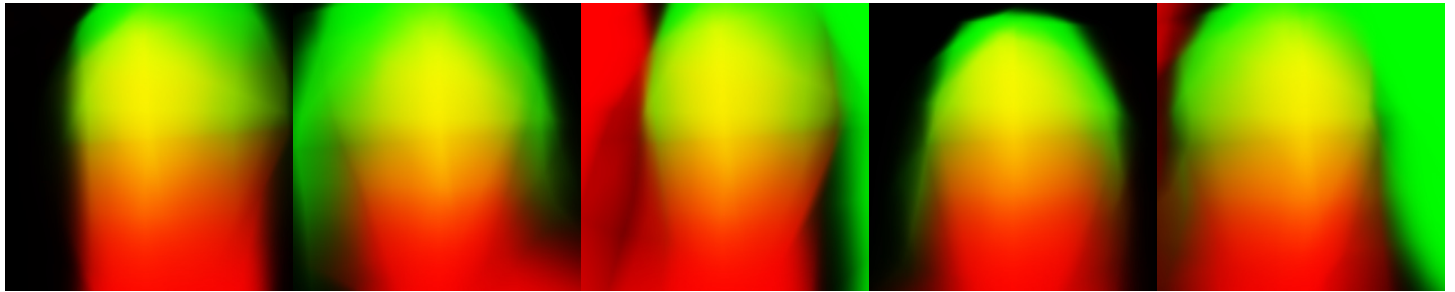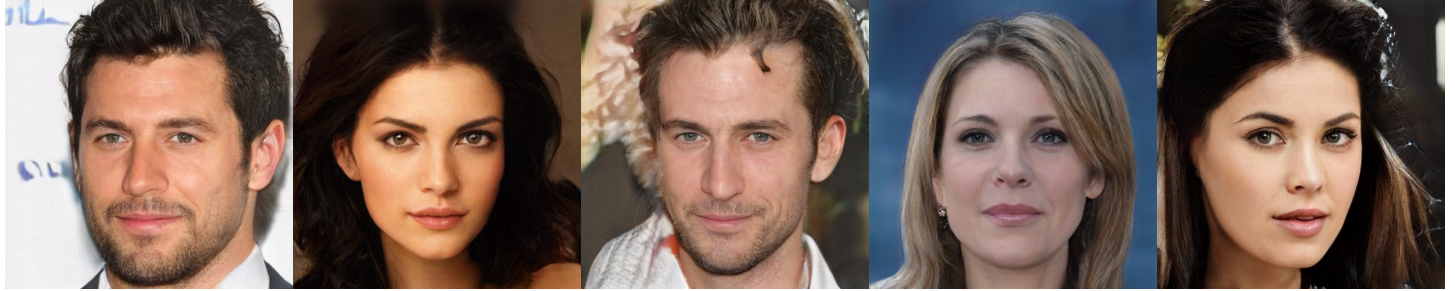
Structure

Texture

Apply Textures learned from art images.
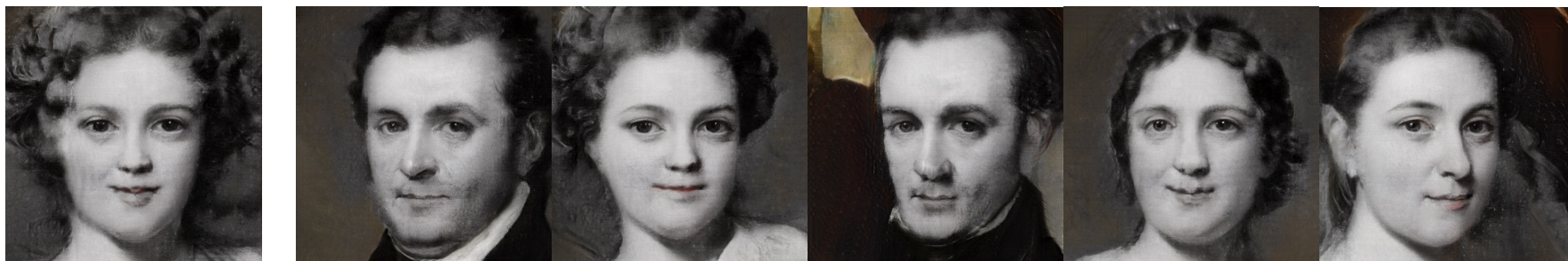
Structure

Texture

Apply Textures learned from art images.
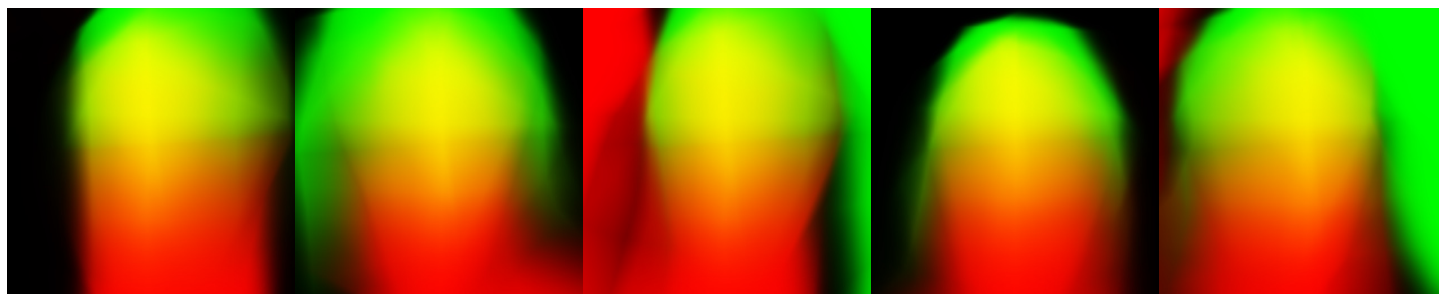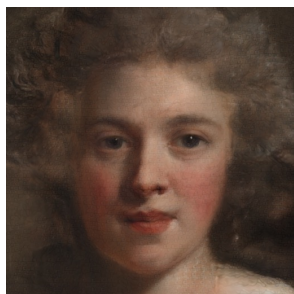
Structure

Texture

Apply Textures learned from art images.
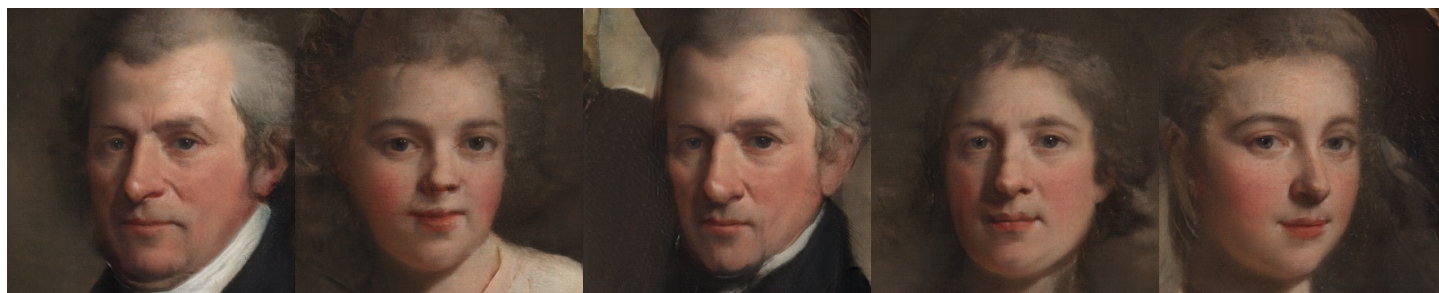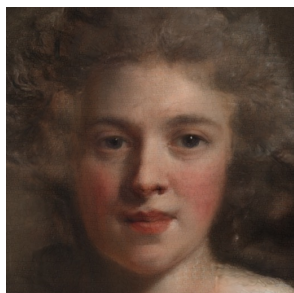
Structure

Texture

Apply Textures learned from art images.

Application in other categories.

Correspondence Map
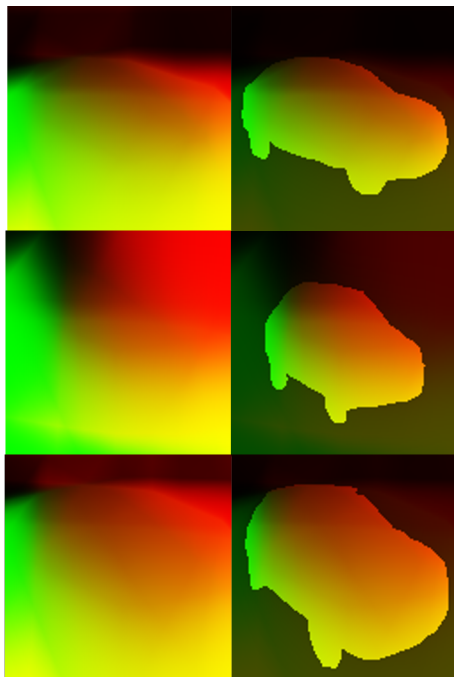
Generated Images
(Each row: same structure; Each column: same texture)

Stanford Cars
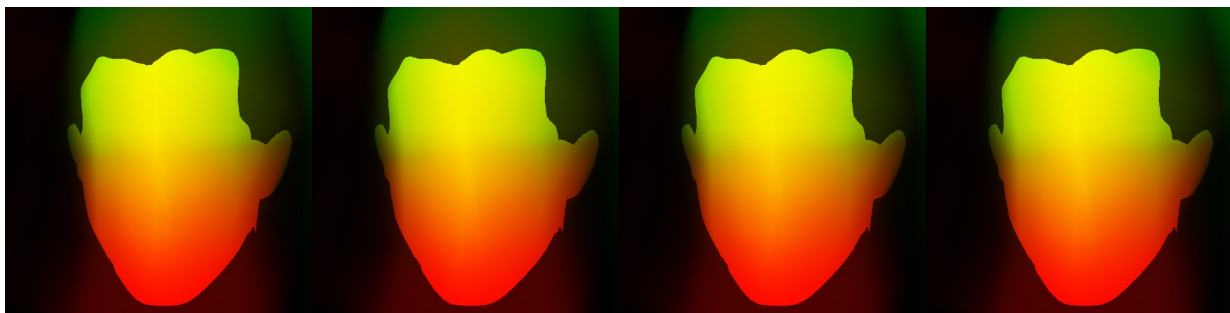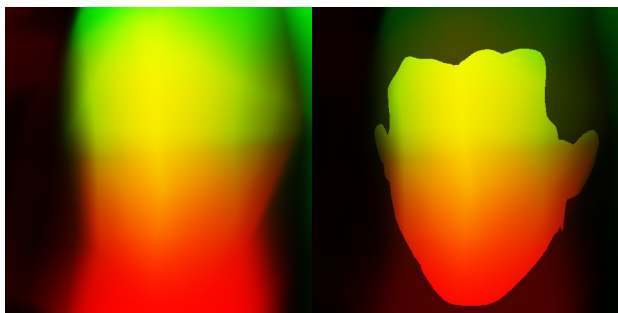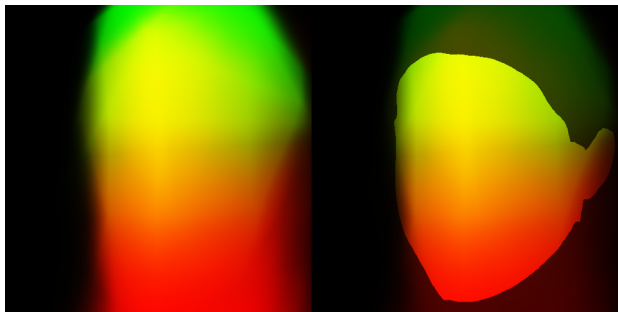
Correspondence Map
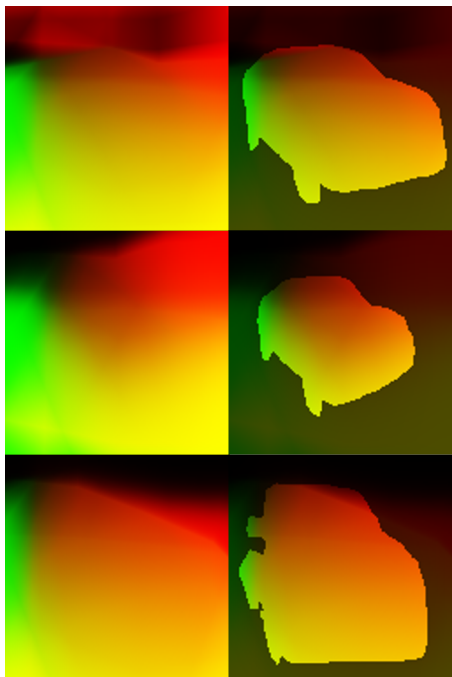
Generated Images
(Each row: same structure; Each column: same texture)

Stanford Cars

Correspondence Map
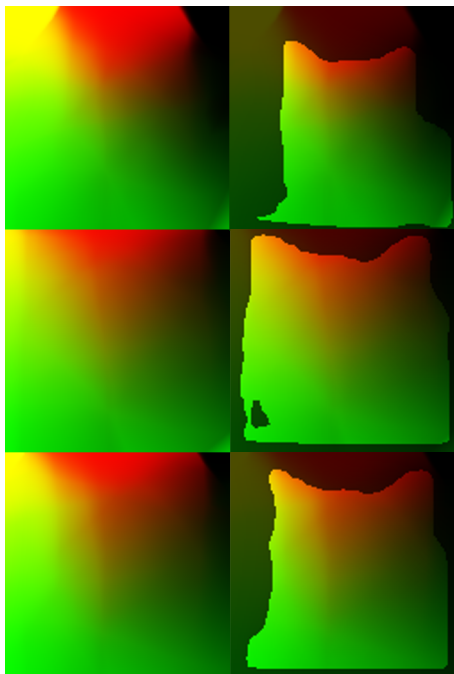
Generated Images
(Each row: same structure; Each column: same texture)

AFHQ-cat

Correspondence Map
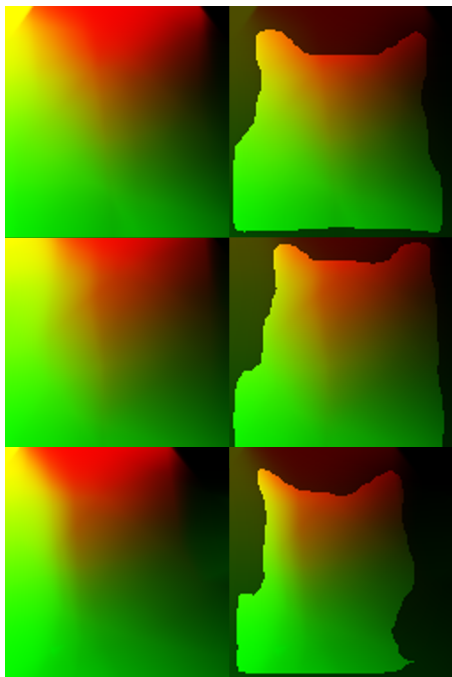
Generated Images
(Each row: same structure; Each column: same texture)

AFHQ-cat

Structure Swapping.

Different Correspondence Maps
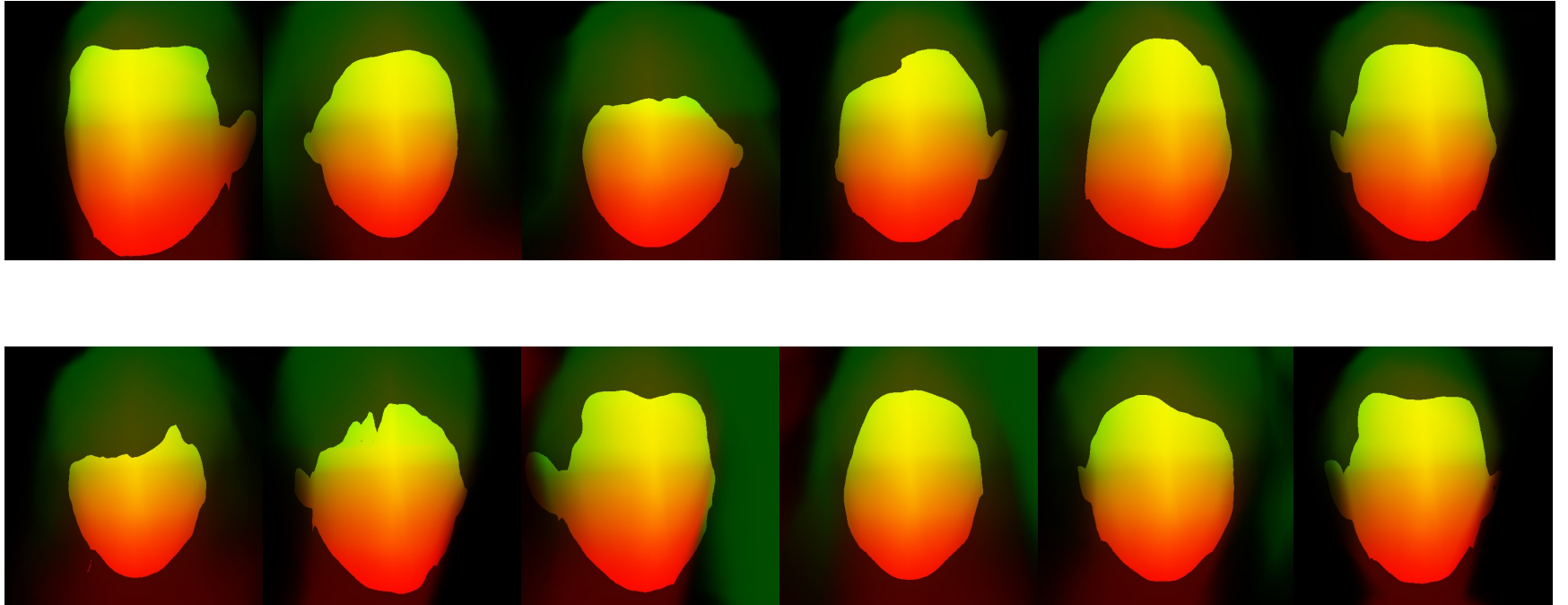
Each row: images with the same texture but different structure codes.

Generated Images

Each row: images with the same texture but different structure codes.

Different Correspondence Maps
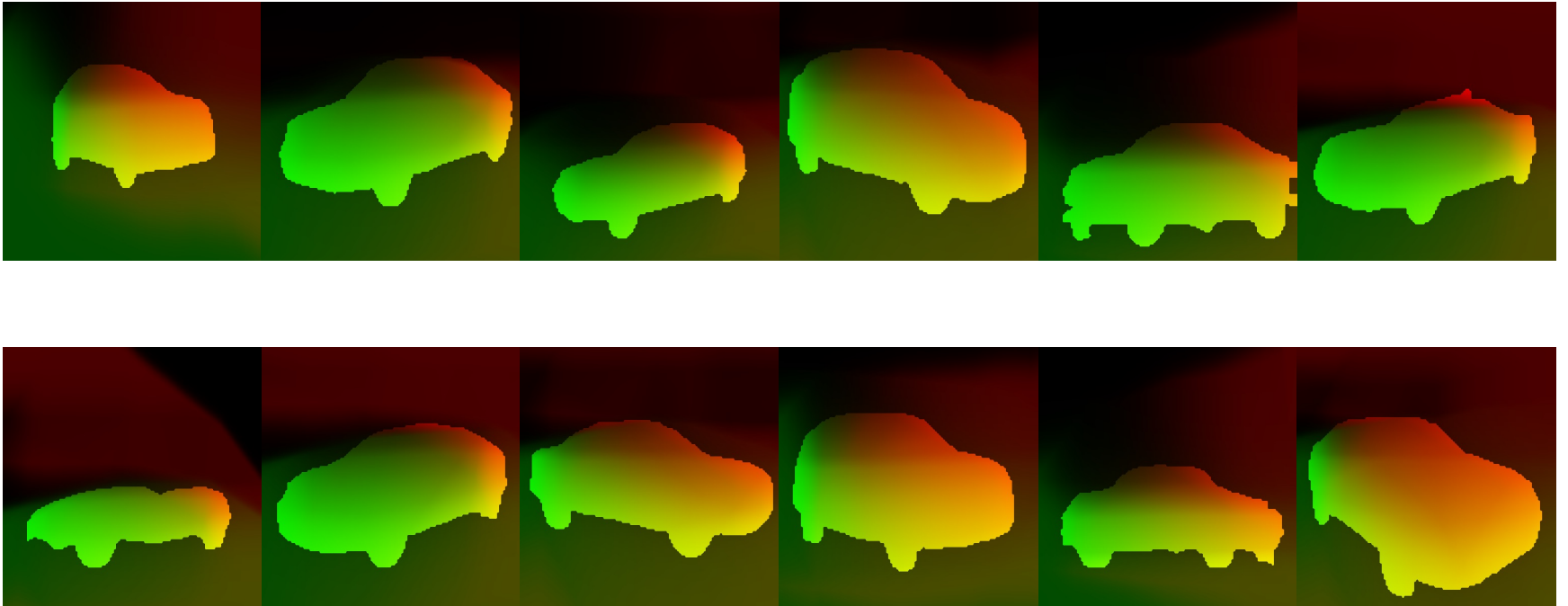
Each row: images with the same texture but different structure codes.

Generated Images

Each row: images with the same texture but different structure codes.

Different Correspondence Maps

Each row: images with the same texture but different structure codes.

Generated Images

Each row: images with the same texture but different structure codes.

CoordGAN Architecture

$$z_s \sim \mathcal{N}(0, 1)$$

Structure
Map Net

$$w^s$$
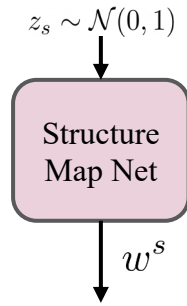
A sampled structure code is mapped to a latent code.
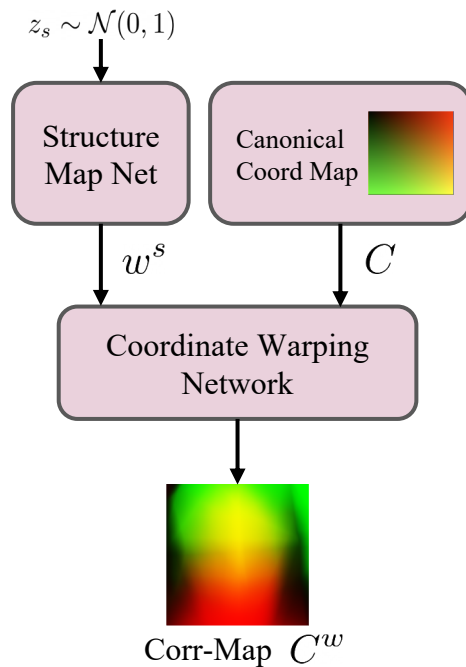
The structure latent code together with a canonical coordinate is passed through the Coordinate Warping Network.
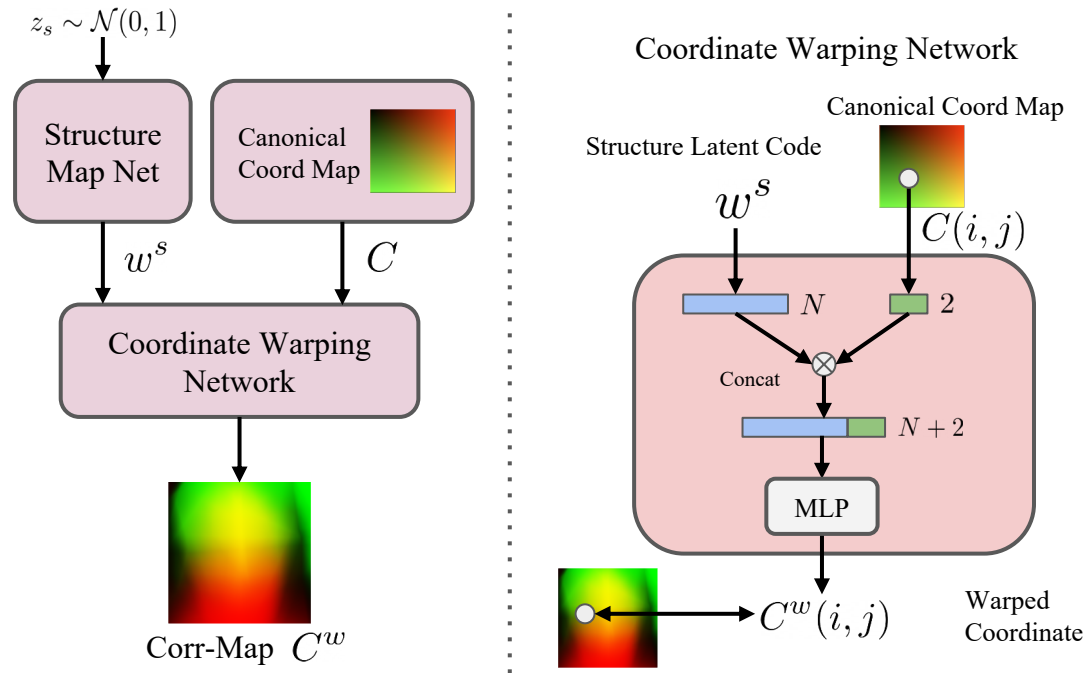
At each spatial location, the Coordinate Warping Network predicts the corresponding canonical coordinate.

$z_t \sim \mathcal{N}(0, 1)$

Texture Map Net

w_t

$z_s \sim \mathcal{N}(0, 1)$

Structure Map Net

Canonical Coord Map

w^s

C

Coordinate Warping Network

Corr-Map C^w

Coordinate Warping Network

Canonical Coord Map

Structure Latent Code

w^s

$C(i, j)$

N

2

Concat

$N + 2$

MLP

$C^w(i, j)$

Warped Coordinate
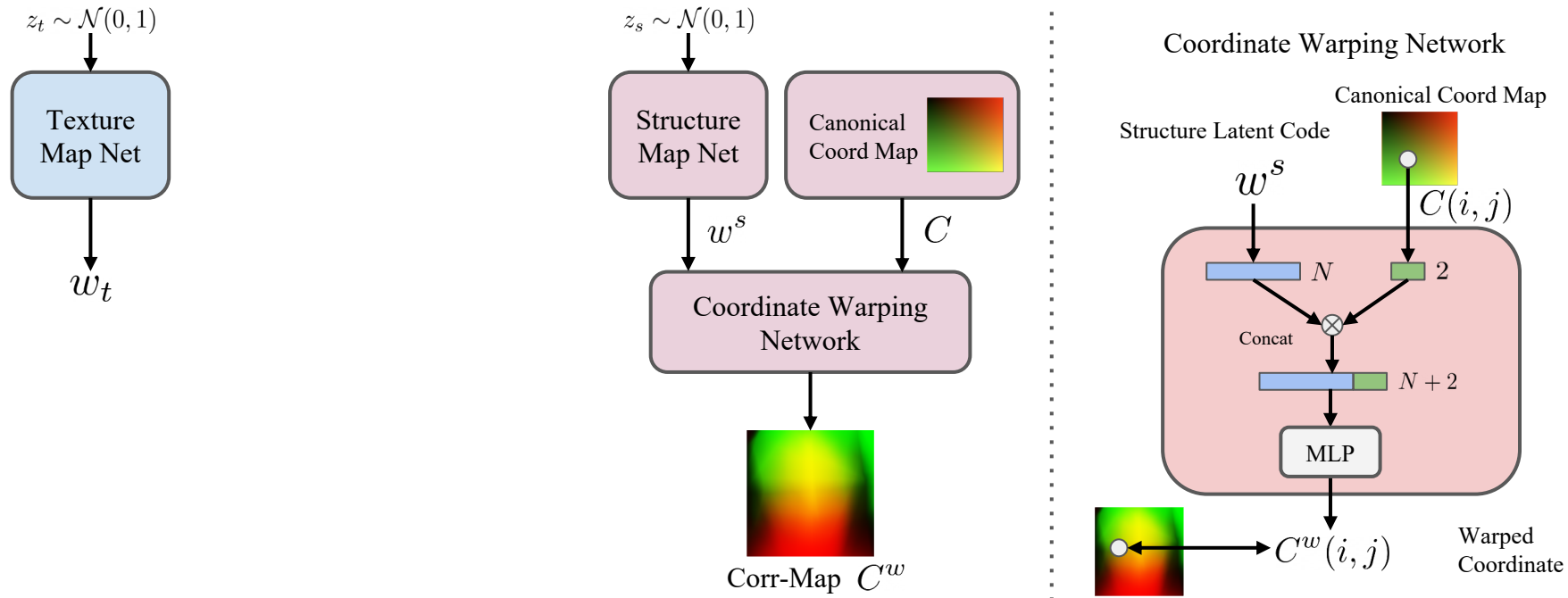
A sampled texture code is also mapped to the latent space.
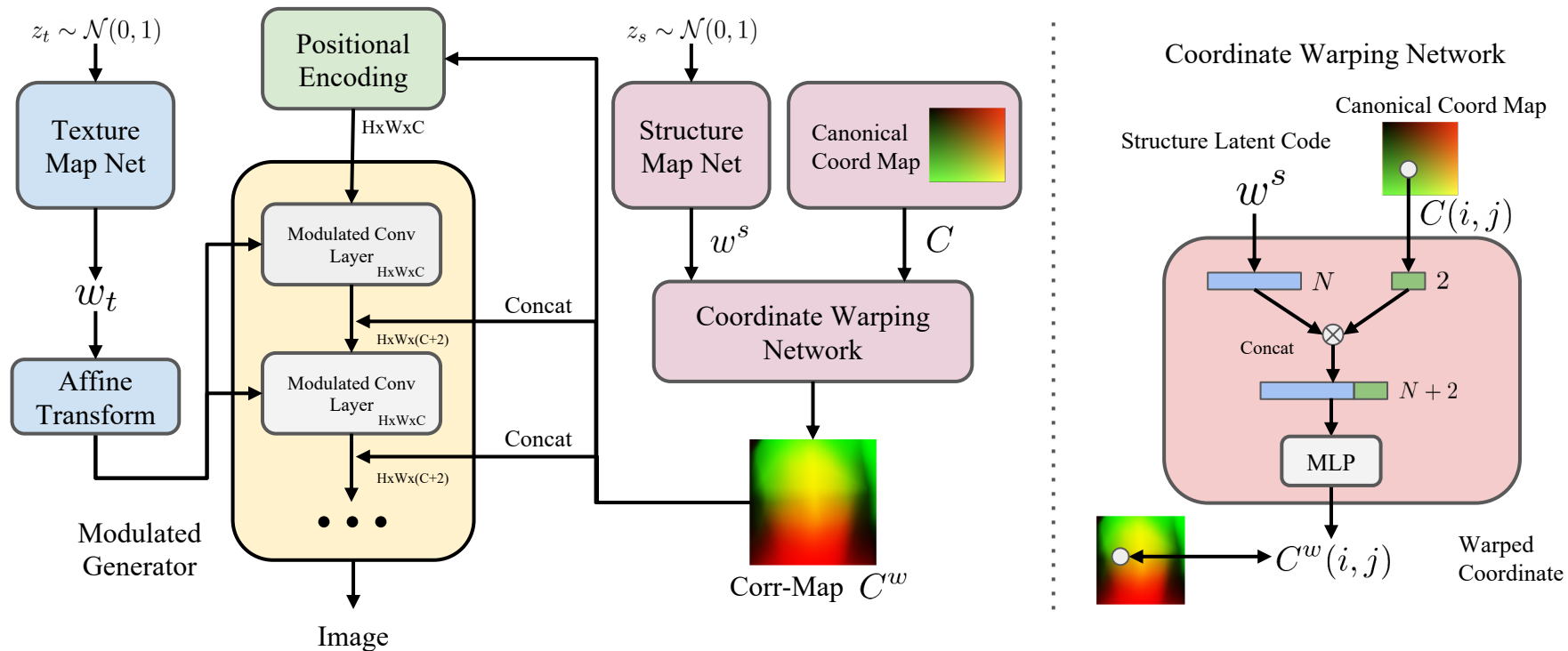
The Modulated generator takes as input both the latent texture code and correspondence map, and synthesize images.

Inverting CoordGAN via an Encoder
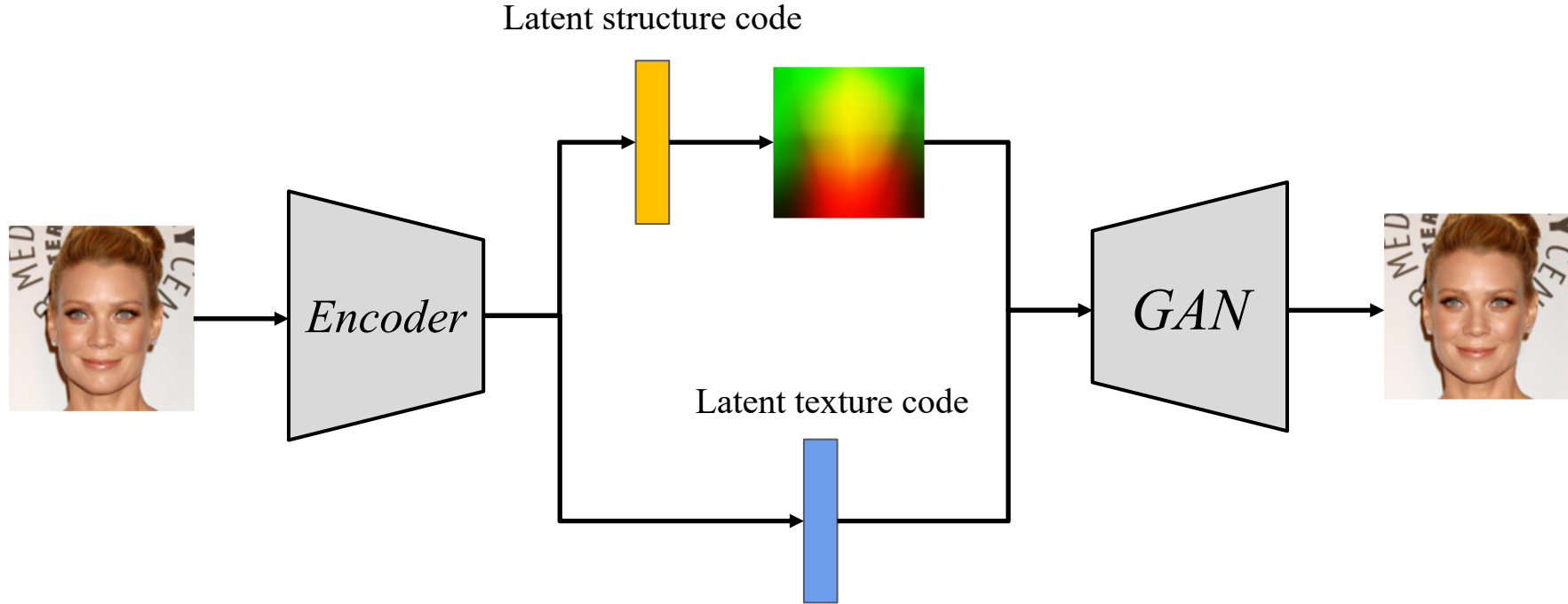
To extract correspondences from real images, an additional encoder is trained by reconstructing the input.

Latent structure code

Correspondence map
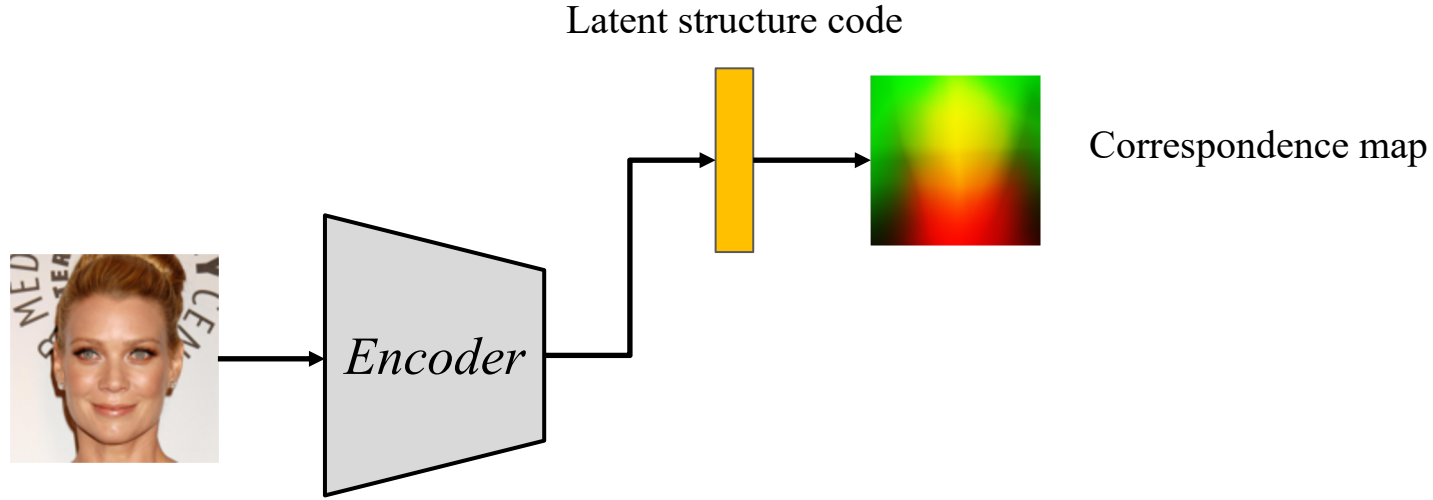
Encoder

Once trained, the encoder establishes the mapping from an input image to a dense correspondence map.

Semantic Label propagation.

Label propagation

Reference Image   Reference Labels   Query Image   Query Image

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

| Reference Image | Correspondence | Query Image | Correspondence | Query Image | Correspondence |

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Reference Image · Reference Labels · Query Image · Propagated Labels · Query Image · Propagated Labels

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Reference Image   Reference Labels   Query Image   Query Image

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Label propagation

| Reference Image | Correspondence | Query Image | Correspondence | Query Image | Correspondence |

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Label propagation

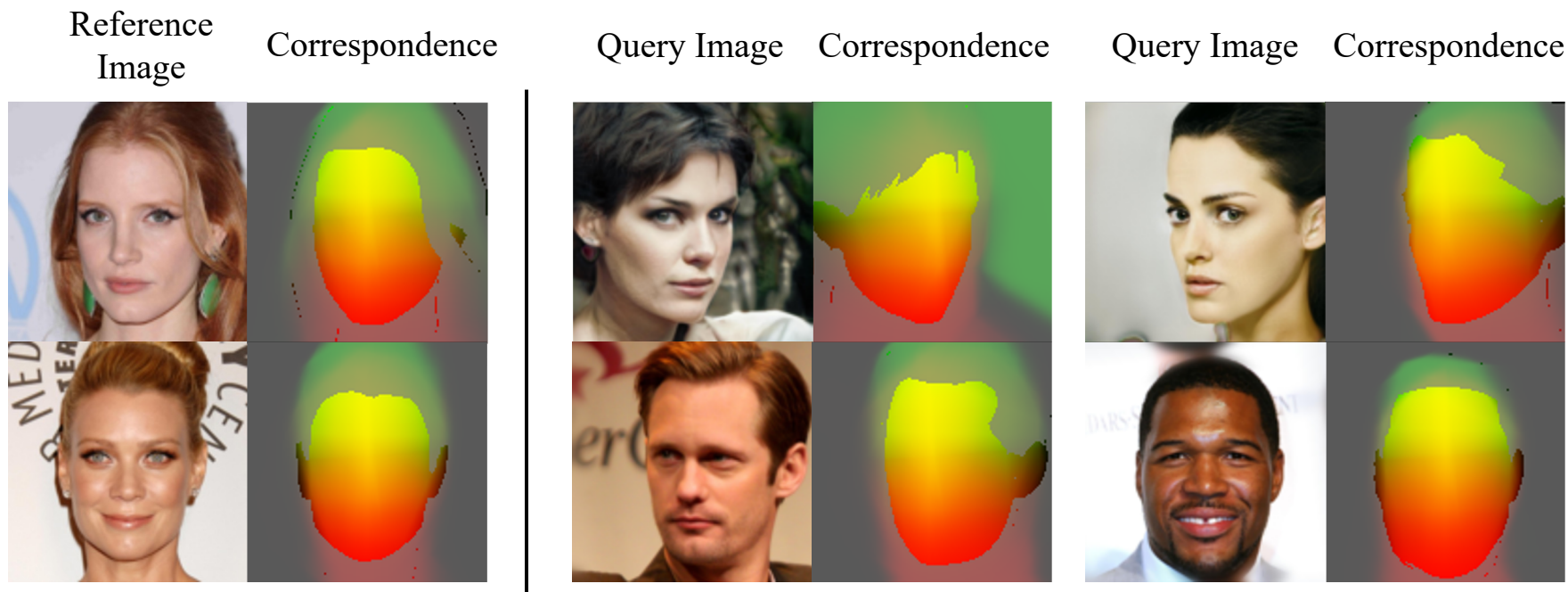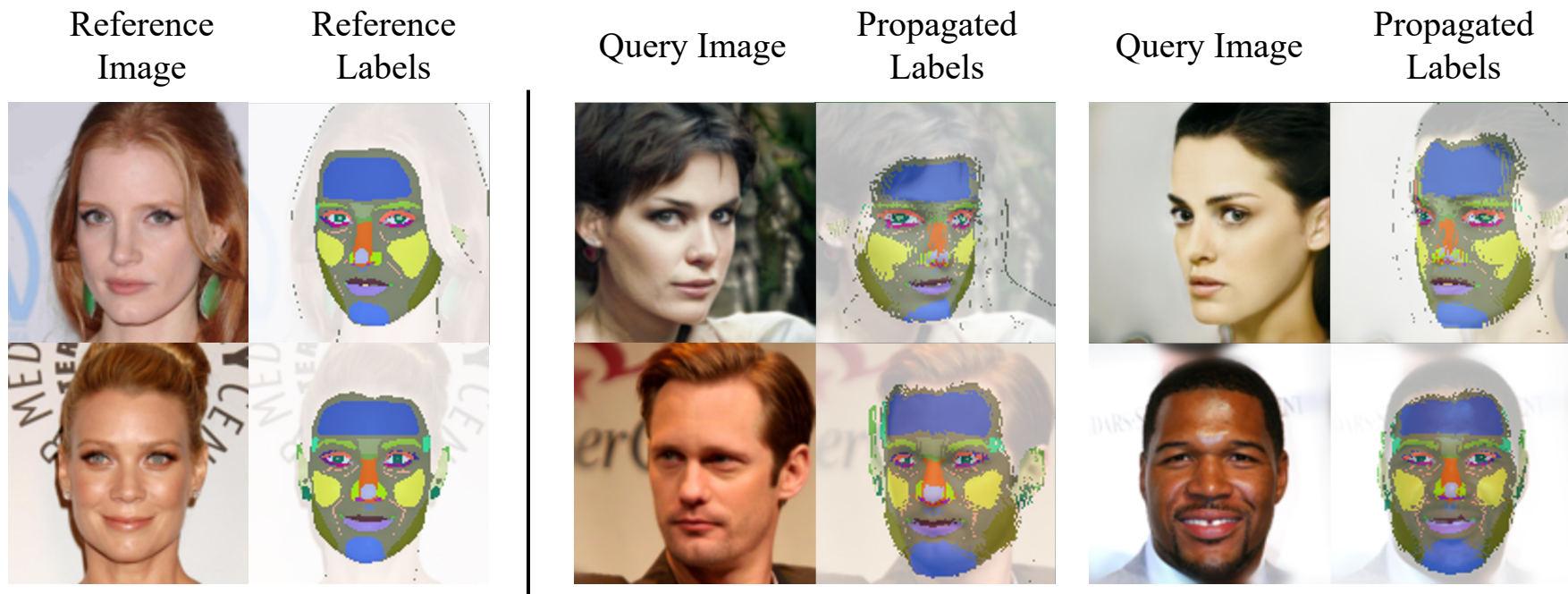Reference Image   Reference Labels   Query Image   Propagated Labels   Query Image   Propagated Labels

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Reference Image   Reference Labels   Query Image   Query Image

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.
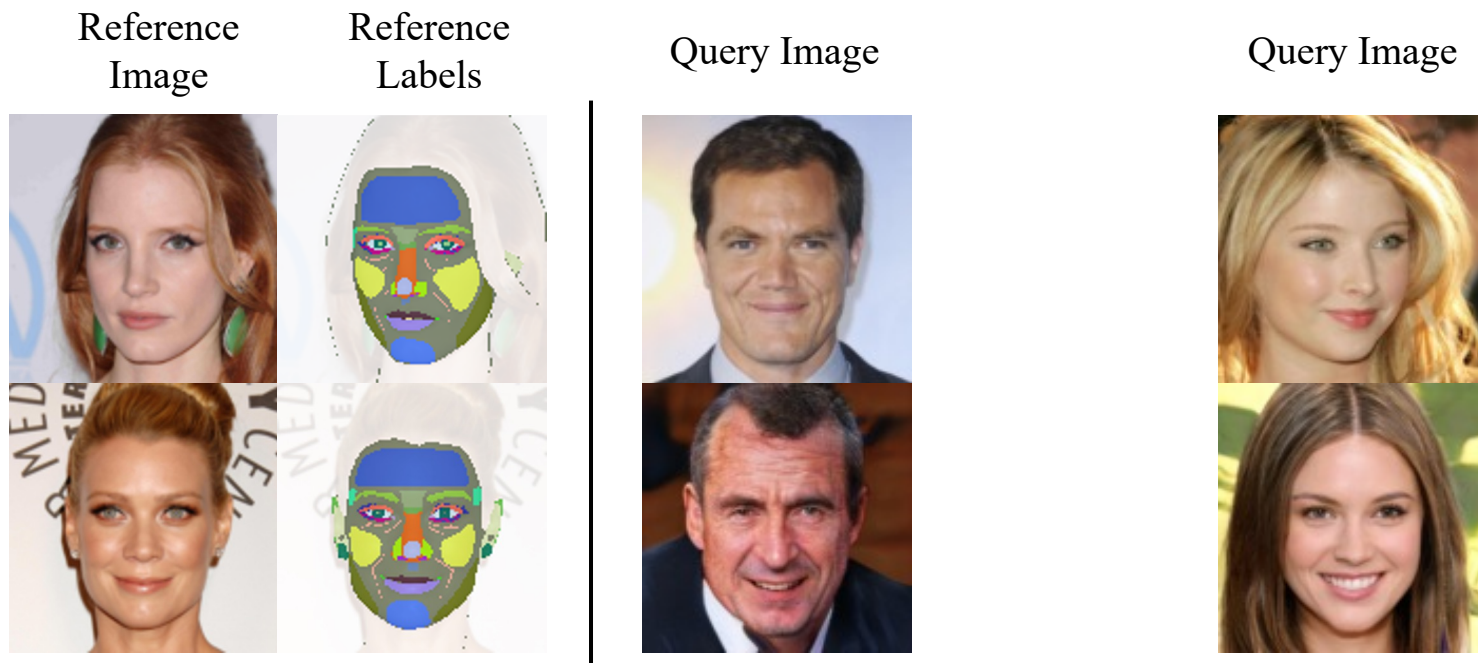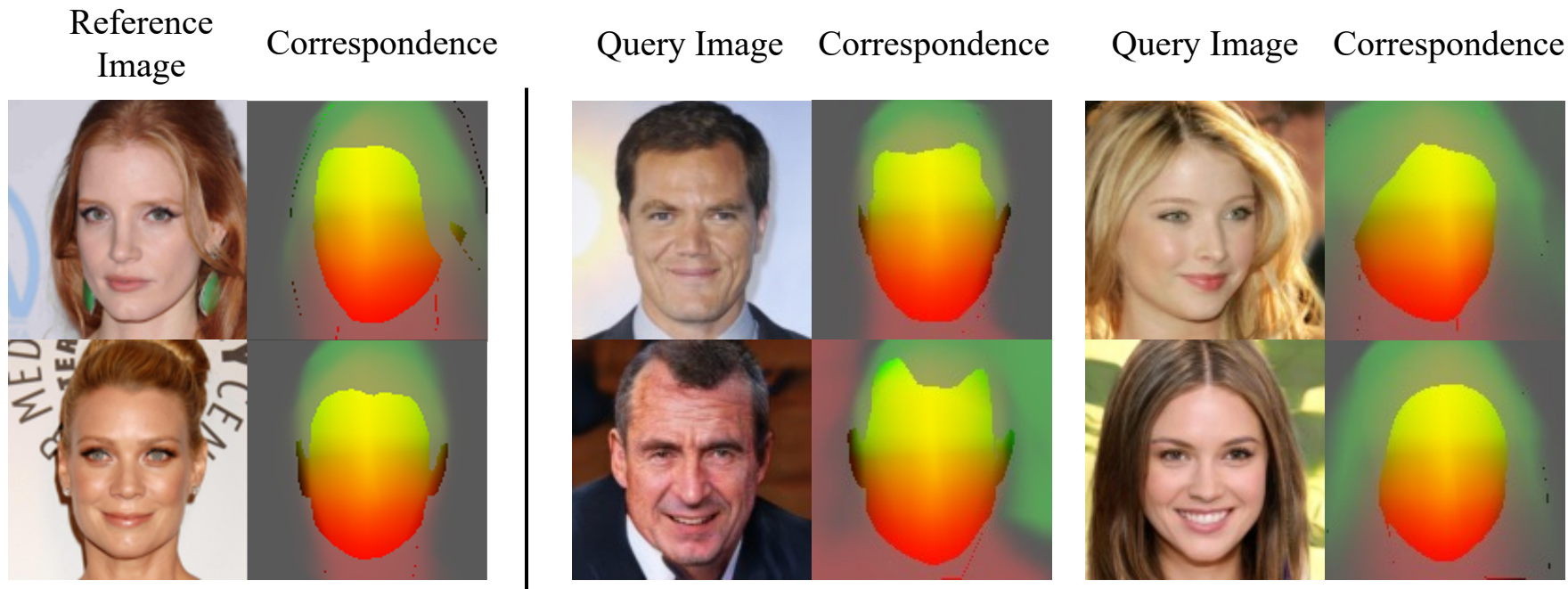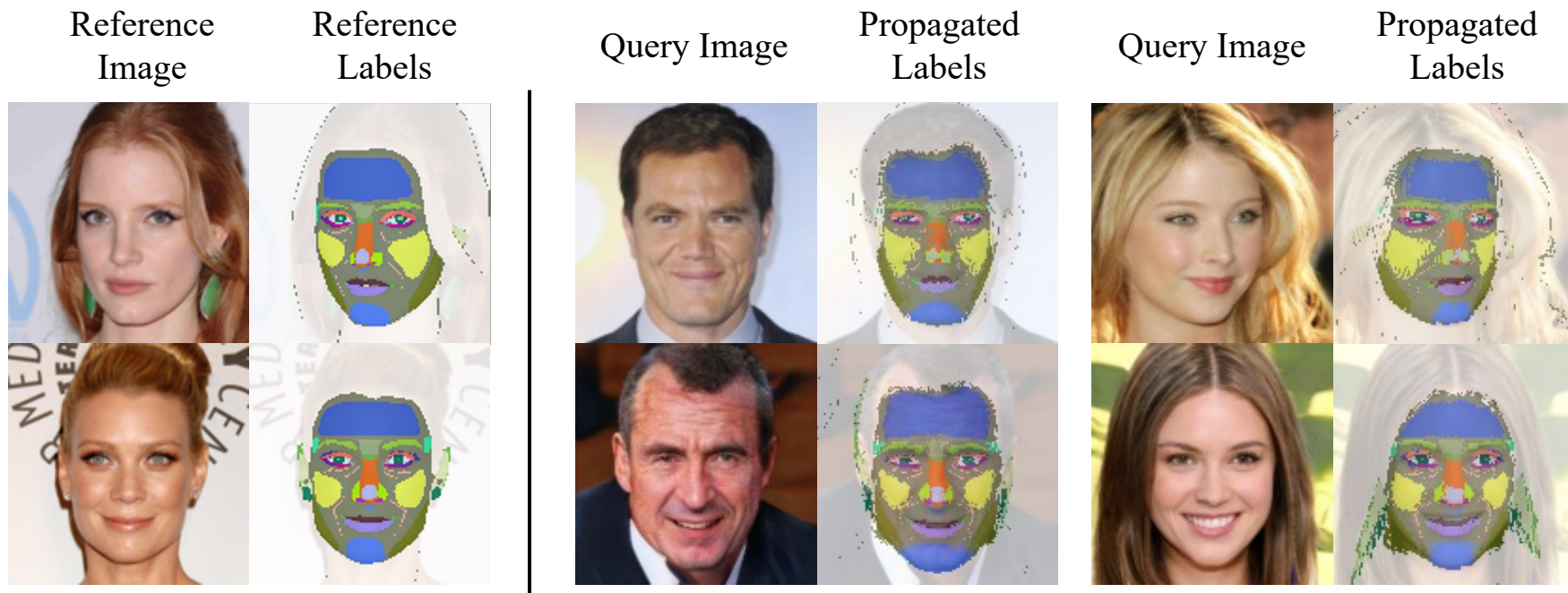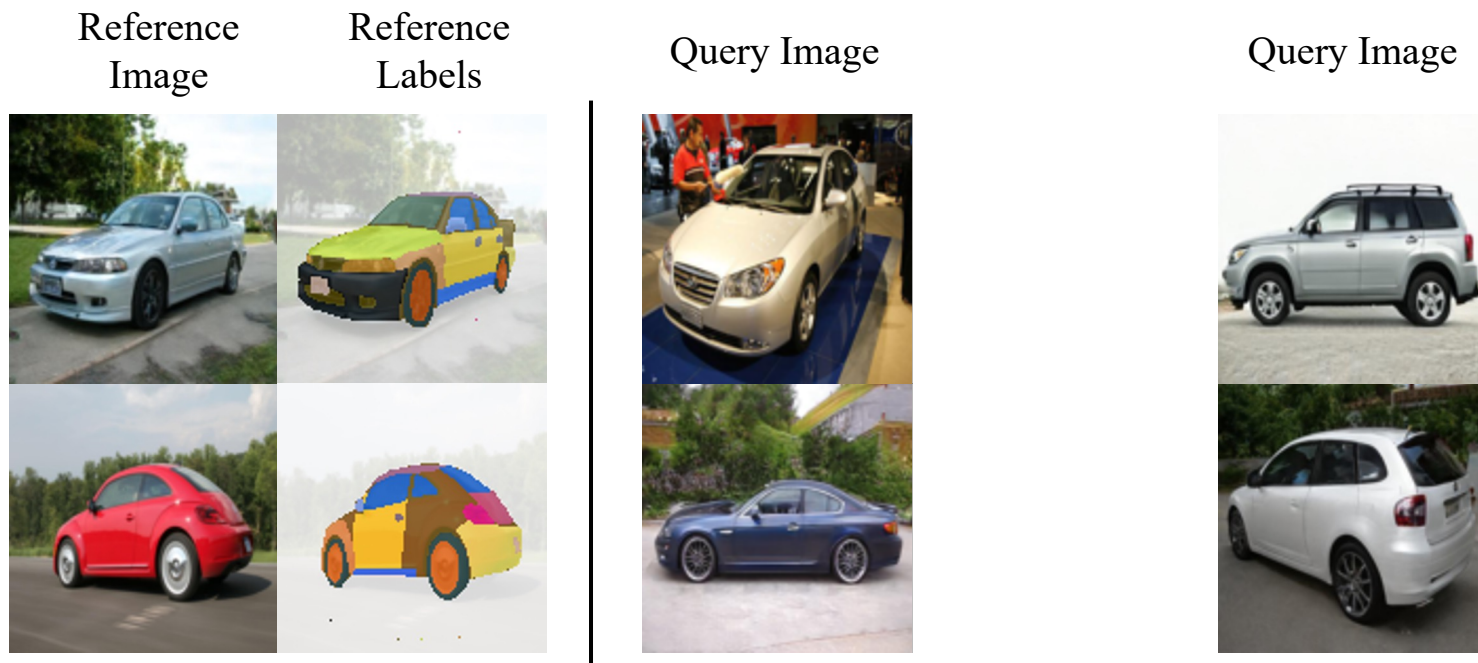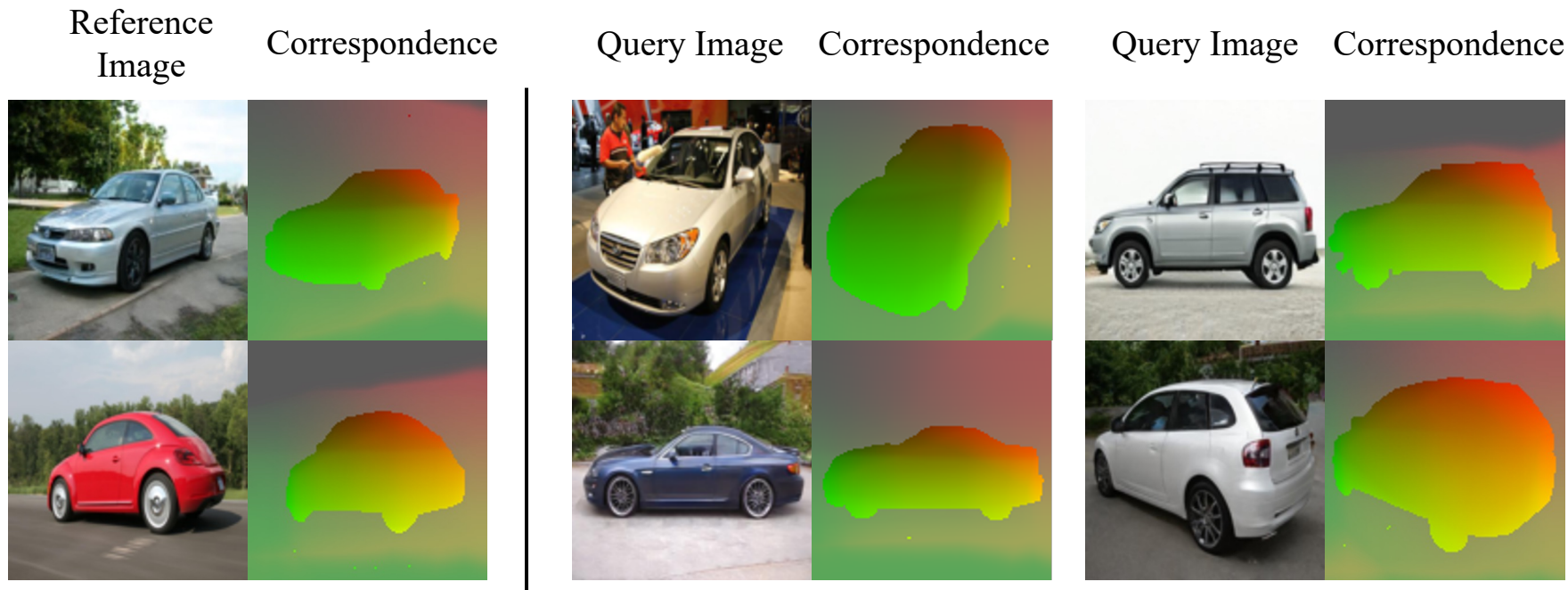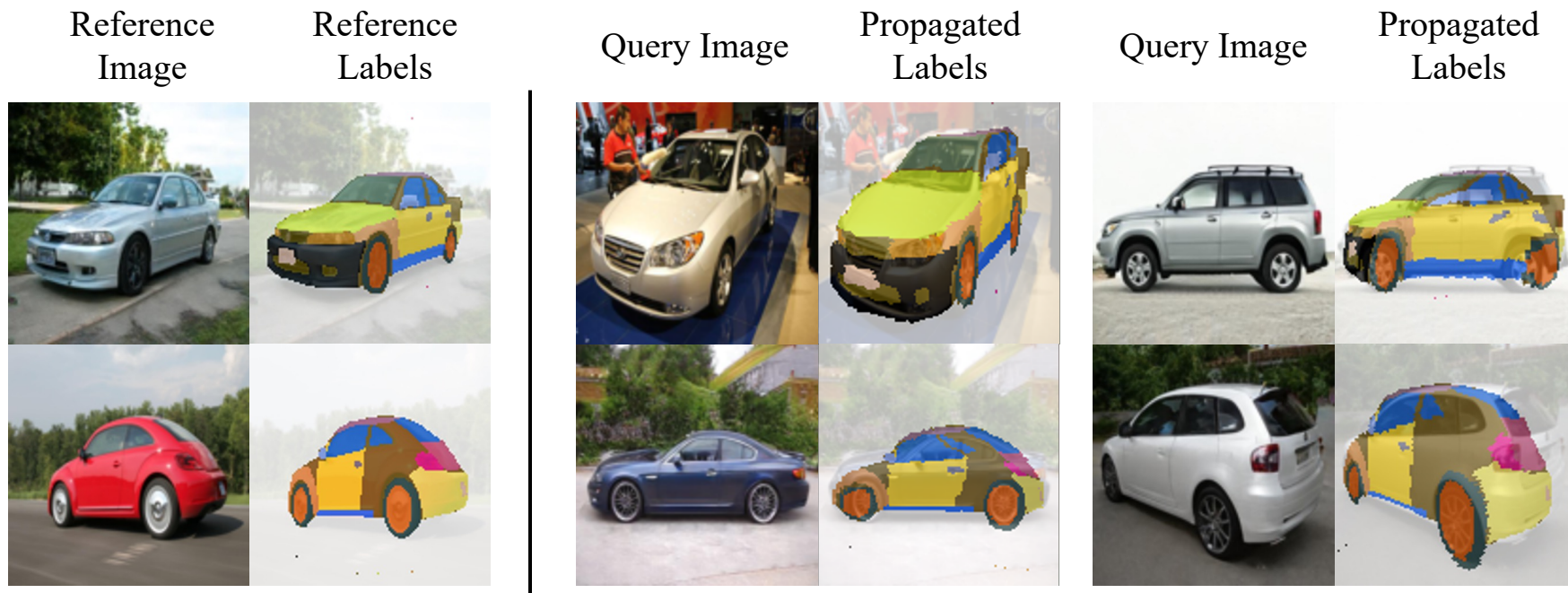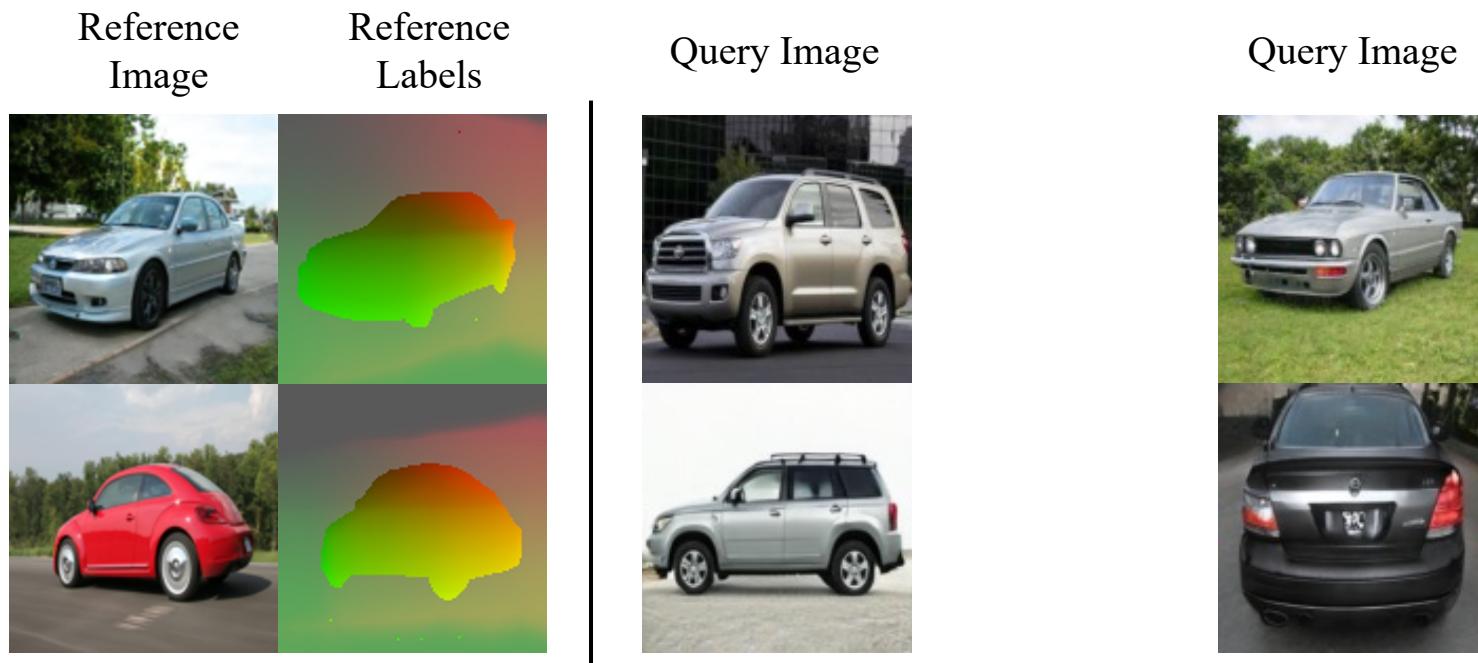
Label propagation

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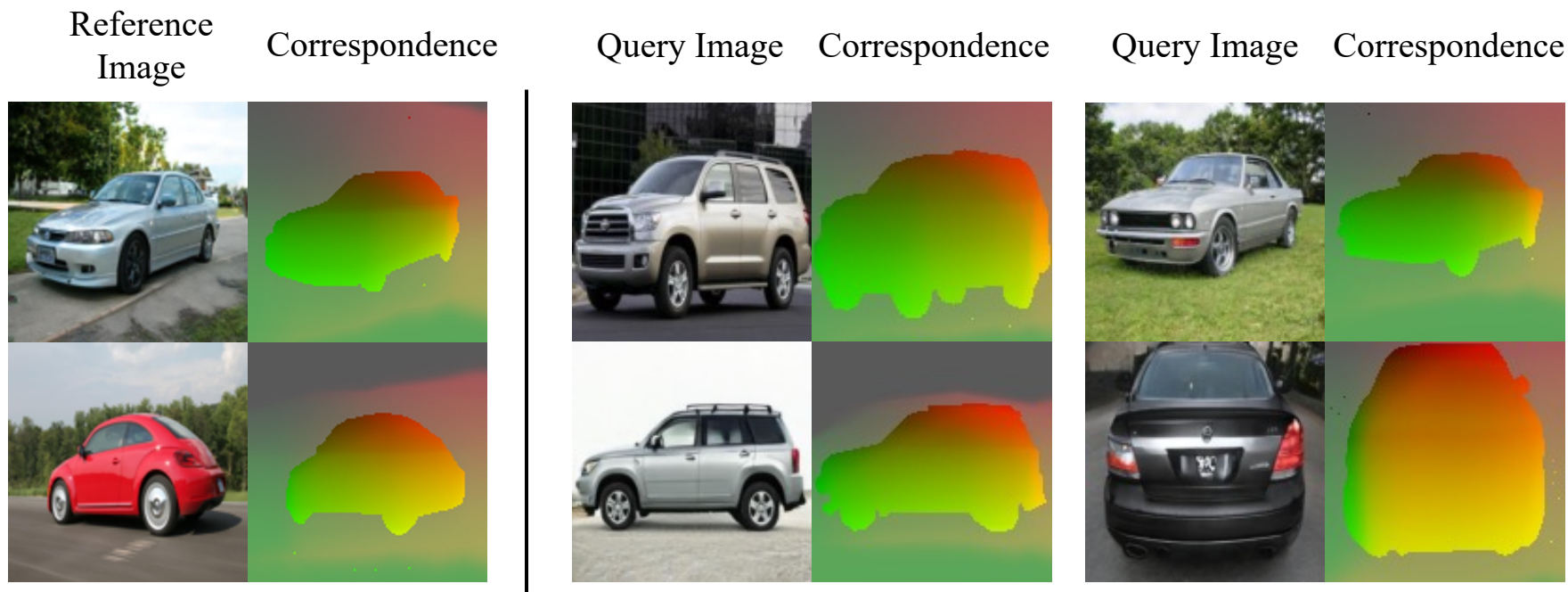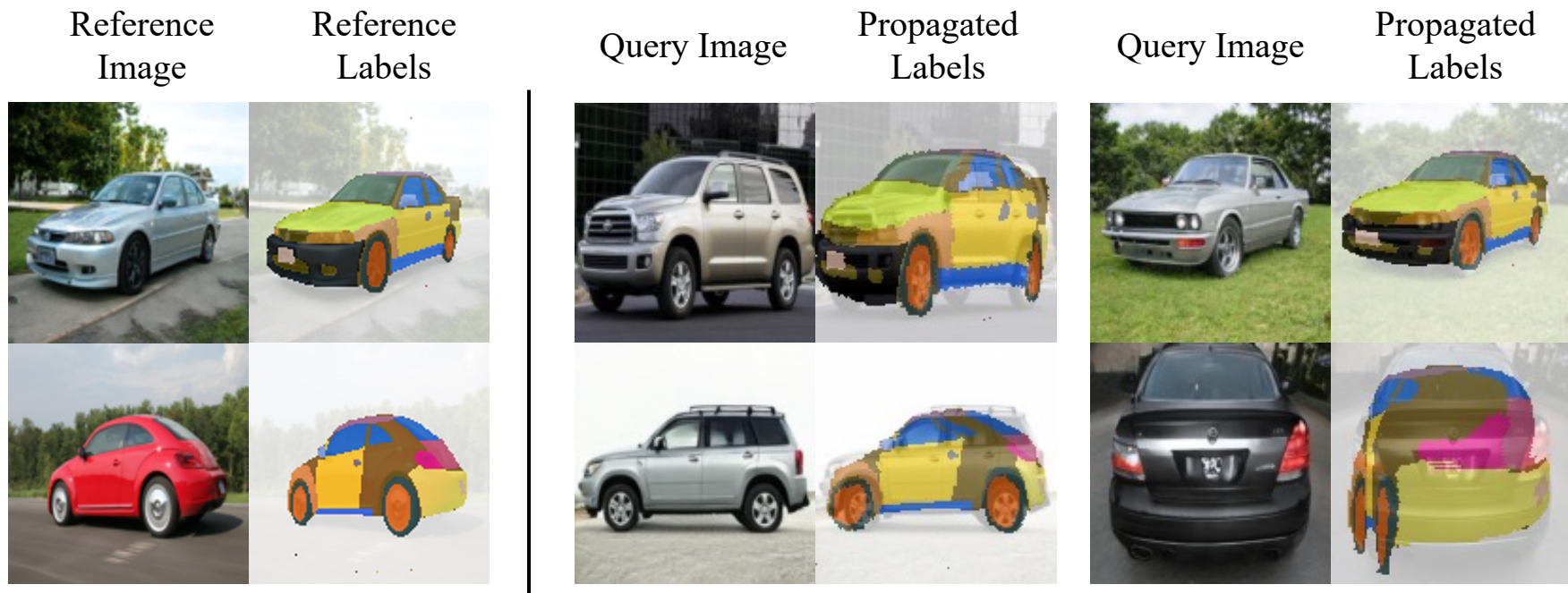
Label propagation

Reference Image　Reference Labels　Query Image　Query Image

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Reference Image · Correspondence · Query Image · Correspondence · Query Image · Correspondence

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.

Label propagation

Reference Image · Reference Labels · Query Image · Propagated Labels · Query Image · Propagated Labels

Given a reference image and its labels, we propagate its labels with correspondence maps to other query images.