Intrinsic Autoencoders for Joint Neural Rendering and Intrinsic Image Decomposition

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Motivation

Render Parameters
Physically-Based Materials
Expert
Physically-Based Rendering
3D Model
Rendered Image

- Does not need any training data.
- Requires high-quality materials.
- Requires expert skills to tune.
- Slow.

Real or Rendered Image
Deferred Neural Rendering
3D Model
Normals Albedo Reflections
Generated Image

- Requires paired real training data.
- Can learn to predict missing input data.
- Requires no expert skills during inference.
- Fast.

Can we train neural rendering using unpaired 3D models and real images ?

Unpaired Datasets

3D CAD Models   Real Image Collection

28 CAD models containing SUV, sedan, hatchback, van, etc.

16,000 Real images from Stanford Cars dataset.

Intrinsic Autoencoders

Deferred Neural Rendering

Train Jointly

Intrinsic Image Decomposition

Method

Rendering Cycle Loss

Input intrinsics → Deferred Neural Renderer → Generated Image → Intrinsic Image Decomposition → Reconstructed intrinsics

Shared Intrinsics Discr.

Shared Image Discr.

Input Image → Intrinsic Image Decomposition → Generated Intrinsics → Deferred Neural Renderer → Reconstructed Image

Decomp. Cycle Loss

Neural Rendering Results

Reflections Albedo Normals (column labels repeated for each example)

Comparing FID and KID scores

	Cycle GAN	MUNIT	Ours	w/ Shared Discr	w/o Decom. Cyc.	w/o A	w/o N	w/o F
FID	103.3	99.0	**47.6**	59.2	99.6	88.7	60.2	56.7
KID	10.2	13.5	**4.2**	4.8	11.8	5.4	4.9	5.9

Human Subject Study on Amazon MT

	Cycle GAN	MUNIT	Ours	w/o Shared Discr.	w/o Decom Cyc.
Real Im	77.7%	75.6%	**67.5%**	68.9%	71.0%
Ours	80.0%	85.8%	–	57.6%	63.8%

Input   Our full model   Ours without Shared Discriminator   Ours without Decomposition Cycle   CycleGAN   MUNIT

Intrinsic Decomposition Results

Real input image   Normals   Reflections   Albedo   Re-rendered image

Full Model   w/o Shared Discr   w/o Decomp Cycle   CycleGAN   MUNIT

Input Real Image

Albedo   Reflection   Normals