Locally Stylized Neural Radiance Fields

Hong-Wing Pang[1], Binh-Son Hua[2,3], Sai-Kit Yeung[1]

[1] Hong Kong University of Science and Technology [2] Trinity College Dublin [3] VinAI

ICCV23 PARIS

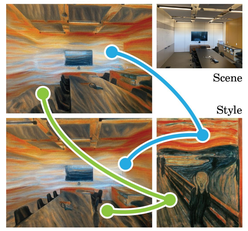
Motivation

NeRF Style transfer - Transferring the style of a reference image onto a NeRF scene in a consistent way across different novel views.

- Previous stylization methods suffer from repetitive patterns and lack of controllability.
- We propose a novel method with improved and customizable stylization results.

Methodology Overview

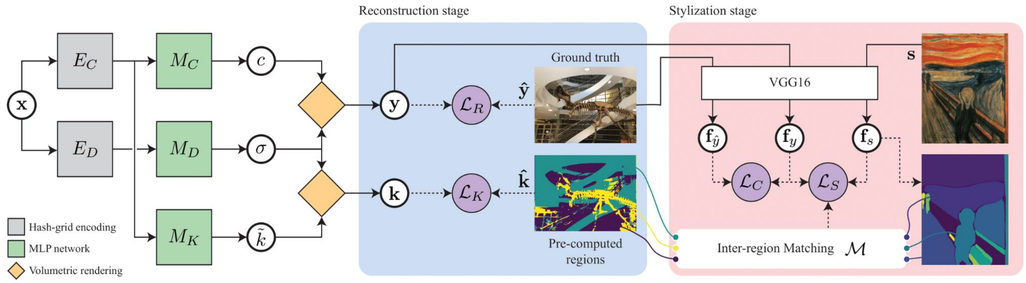
- Style image is segmented into S *style regions*
- Each ground truth image is segmented into C *scene regions*
- **Reconstruction stage:** NeRF model is trained to learn the following simultaneously:
  - Render ground truth images via regular NeRF training with MSE loss
  - Predict the scene region segmentation map for any arbitrary novel view
- Each scene region is matched with a unique style region via the *Hungarian algorithm*, based on the following:
  - Position of region
  - Feature similarity



- **Stylization stage:** NeRF model is fine-tuned using the following losses:
  - Style loss (L_S): for each VGG feature from rendered image, compute distance with nearest style image VGG feature *in matched style region*
  - Content loss (L_C): L2 distance between content and style feature maps

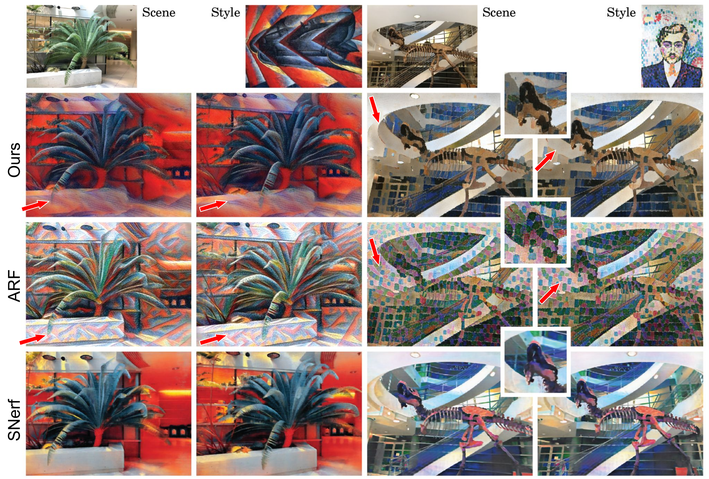
Training Pipeline

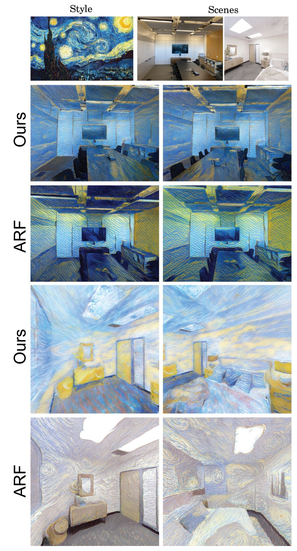
- We use a variant of Instant-NGP [1] as the NeRF backbone to facilitate fast training.
- Two separate hash grids (for color and density) are used to store the positional encodings of any arbitrary input position **x**. During the stylization stage, only E_C is fine-tuned.
- The MLP network M_K is used to predict the segmentation maps of any rendered novel view.



Baseline Comparisons *with SNerf [2] and ARF [3]*

Under our method, different local styles across the style image can be transferred, reducing the amount of repetitive patterns. (see red arrows)





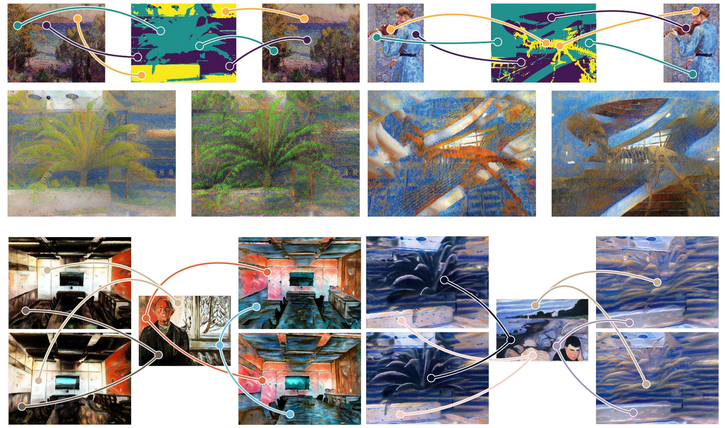
Additional Functionalities

We modify the hash function used in the positional encoding hash grid to provide the following features:

- Modify hash coefficients to get different stylization results.
- Simultaneously train multiple styles within a single model.

Customization of stylization

The matching between scene / style regions can be altered manually to obtain diverse stylization results.



References

[1] Thomas Muller, Alex Evans, Christoph Schied, and Alexander Keller. Instant neural graphics primitives with a multiresolution hash encoding. ACM Trans. Graph., 2022.

[2] Thu Nguyen-Phuoc, Feng Liu, and Lei Xiao. Snerf: Stylized neural implicit representations for 3d scenes. ACM Trans. Graph., 2022.

[3] Kai Zhang, Nick Kolkin, Sai Bi, Fujun Luan, Zexiang Xu, Eli Shechtman, and Noah Snavely. Arf: Artistic radiance fields. ECCV 2022.

Paper / Code