

ART AND MACHINE LEARNING
CMU 2022 SPRING
PROJECT 2 GROUP 11

Stylized 3D Synthesis



Francisco Cabrera (School of Computer Science, Bachelors)
Xiwen Chen (Language Technologies Institute, Masters)
Sebastian Montiel (Electrical and Computer Engineering, Masters)

DESCRIPTION

In this project we attempted to apply machine learning methods to integrate artistic styles into 3D synthesized objects from daily lives with instant-ngp. We applied multiple style transfer techniques, including STROTSS, Fast Style Transfer and DeepDream. Then we synthesized the 3D objects using instant-ngp.

Concept

Inspired by the style transfer methods introduced in lectures, we attempted to make a step forward to apply these methods in industrial productions. Specifically, we want to integrate different artistic styles in synthesized 3D objects from our daily lives using machine learning algorithms. In this way, with artistic paintings as input, these algorithms potentially serve as a path to automatic design for industrial productions. As the very first exploration, we experimented with the NeRF dataset, and applied multiple style transfer techniques, as a hope to combine the notion of art and industrial design.

Technique

The NeRF Dataset

We used the synthetic datasets from [2] because of their proven success with instant-NGP NeRF, and because the transparent background made the images easier to mask, sharpen, etc. Instant-NGP only required the training datasets.

STROTSS

To initially style the chair, we used a reimplementation of the original STROTSS paper from [3]. After some experimentation with different content weights, we found that a content weight around 0.7 produced clear chairs with interesting textures.

Output Masking

The naive application of STROTSS to the training data produced cloudy rendering in instant-NGP since the transparent background took on some of the style. To mitigate this, we created a mask from the training images to revert the background of the styled output images back to transparent. We considered a true masked style transfer rather than just masking the output from STROTSS, but decided against it because the goal of a masked style transfer is for the object being styled to better blend into its background, and the simple output masking had the effect we desired.

Fast Style Transfer

Fast Style Transfer is based on Gatys's original method of neural artistic style transfer. It encodes the image using a VGG network and extracts features from different convolutional layers of the network. The features from different layers exhibit different patterns, and thus represent different levels of abstraction, ranging from content to texture (style) patterns. Then the style features from the style image

are integrated with the content features from the content image, thus transforming the content image to have the style of the style image.

DeepDream

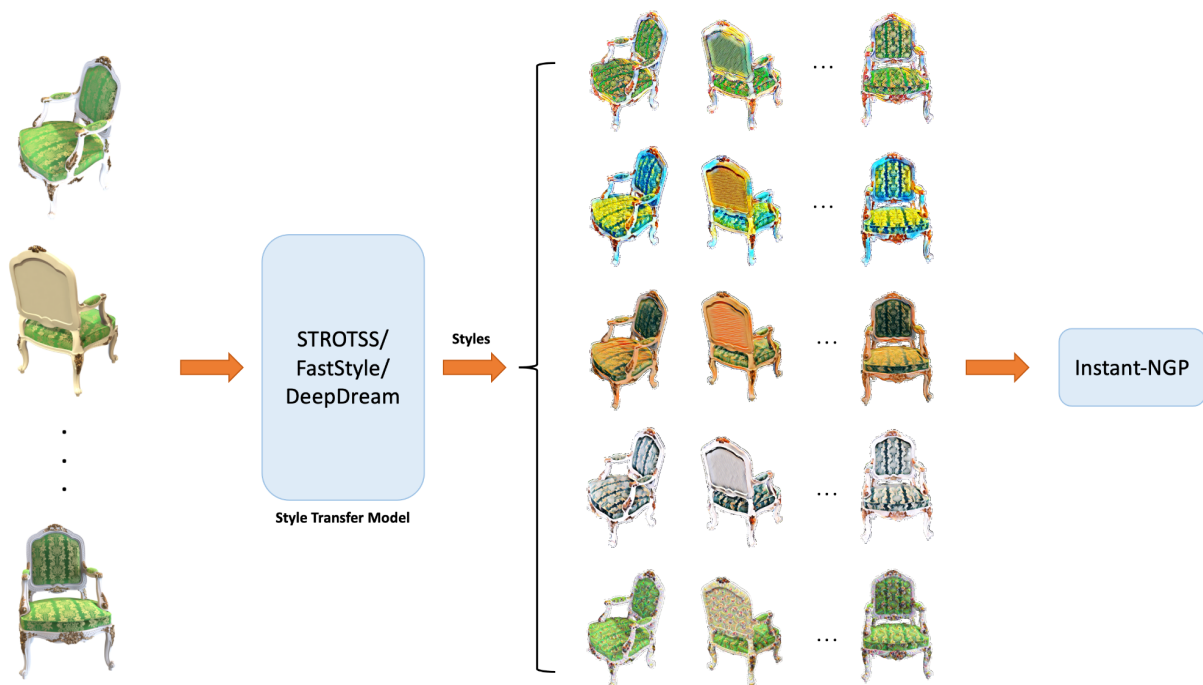
DeepDream was originally designed to gain more insights into the blackbox of neural networks. It takes an image as an input and outputs a dreamy image that looks like hallucinations which exhibits various image patterns. We applied the octave method to incorporate more detailed patterns and get high-resolution images.

Instant-NGP

Instant-NGP is an incredibly fast implementation of NeRF, SDF, neural images, and neural volumes achieved with multiresolution hash input encoding. For our purposes, we only trained NeRF models.

Process

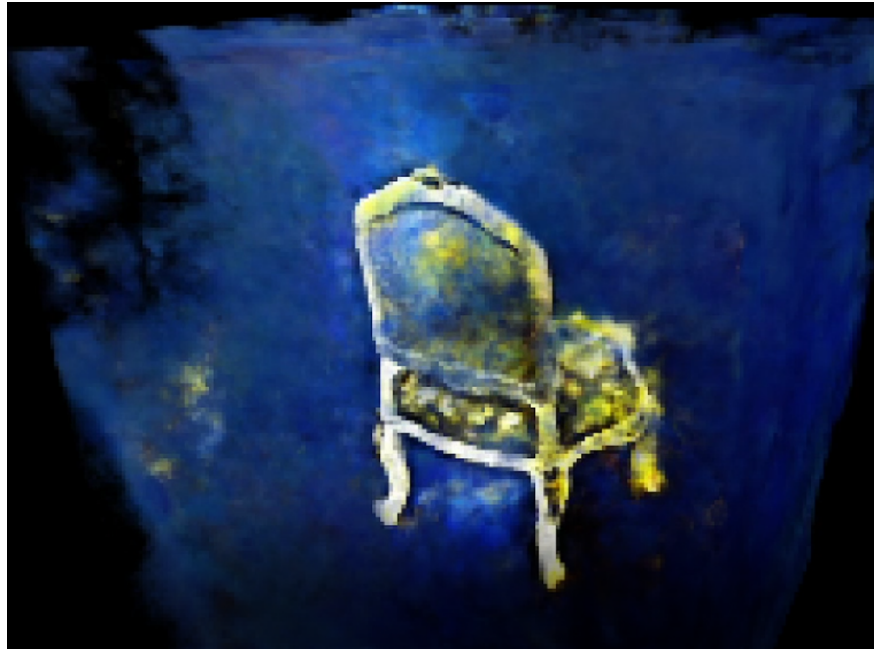
The general procedure of our experiment is as follows: we first applied different style transfer techniques to the training images in NeRF, masked out the background of the objects to be transparent, and finally used instant-ngp to render the 3D object.



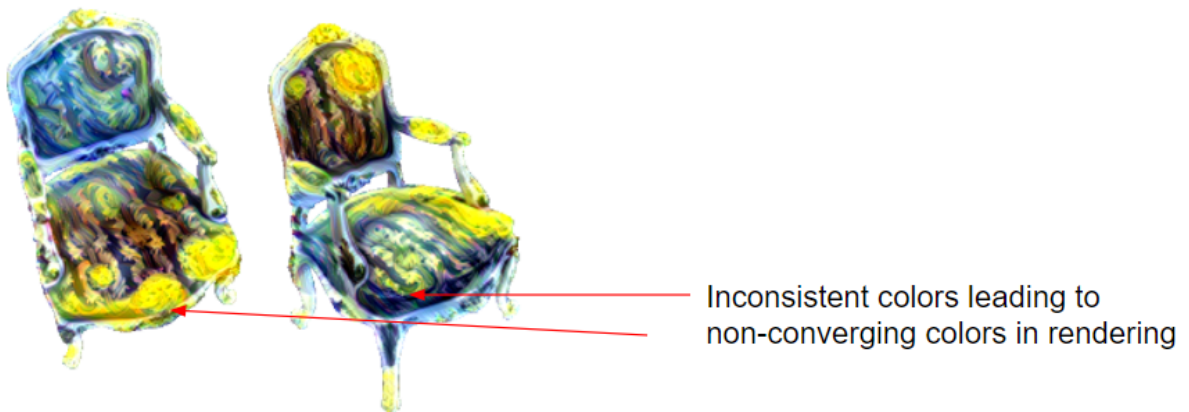
STROTSS (Sebastian)

We initially started with a naive application of STROTSS style transfer to the training images with a high (0.7) content weight in an attempt to preserve the shape of the object. This method had an unintended yet interesting effect where the object was rendered in a sort of cloudy style cube. Following this, an

attempt was made with sharpening on the training data (sharpness_factor=3) which had similar results but with a more distinct chair within the cube (shown below).

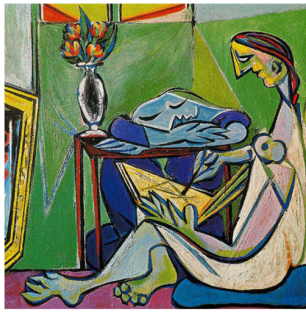


Next, we applied masks to the output of the style transformation before feeding the data to instant-ngp. This obviously removes the cloud and leaves us with a clear mesh of the object that has a constantly evolving texture. This is because the style transfer was unguided, so the different images do not have consistent color placement and instant-ngp is unable to minimize the color loss.



Fast Style Transfer (Xiwen)

After experimenting with the STROSS method, we used the style transfer model to transfer the images to six different artistic styles. This method is based on Gaty's original neural style transfer method, Johnson's design of perceptual losses, and Ulyanov's instance normalization method.



La Muse



Rain Princess



The Shipwreck of the Minotaur



Udnie



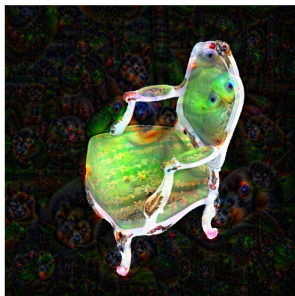
The Scream



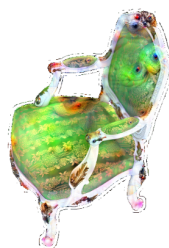
Wave

DeepDream (Xiwen)

DeepDream, started out by Google, established a surprisingly wonderful artistic style in images. Here we applied the DeepDream algorithm to the training images from NeRF with different pattern scales. As we observed from the experiments, with denser detailed patterns in the stylized images, the final constructed 3D object can be integrated with more artistic ingredients. We also tried a simple DeepDream algorithm without applying an octave, which appears to only have an insignificant effect on the style of the image. Same as before, we also applied a mask to the final image to make the background transparent.



Large Scale



Masked



Without Octave



Final

Instant-NGP (Francisco)

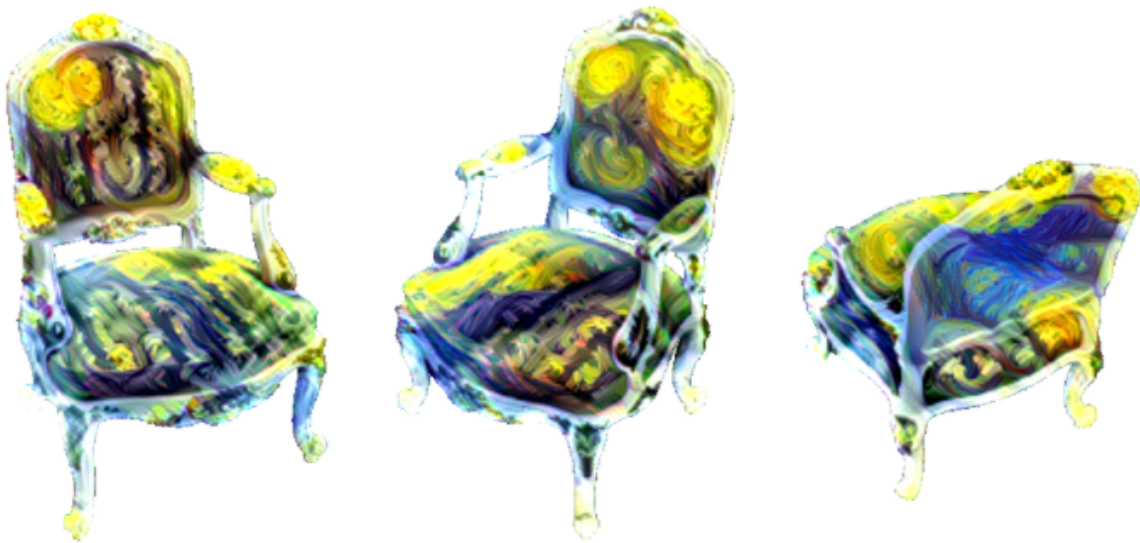
Finally, we used Instant-ngp to render the stylized images and get neural graphics primitives. This allows us to construct 3D objects from 2D images from different view perspectives with minimal running time. The final result of our project is the videos produced by the instant-ngp model showing the objects in 3D.

Reflection

We applied multiple style transfer techniques and finalized our project with 3D synthesized results from instant-ngp. The results show that the combination of the 3D synthesis and artistic style is successful. With Fast Style Transfer, we were able to extract textures from artistic paintings and integrate them into the objects. Although the DeepDream method sometimes fails to produce 3D synthesis with style included, with increasing levels of detail and decreasing scales of patterns, we can still effectively incorporate the style into the image to some extent. We have included the stylized images and videos of 3D synthesis as our final results.

RESULT

STROSS



<https://drive.google.com/drive/folders/1rw03Ox9kgDVUSM27W2tNshZUeFGtv3lR?usp=sharing>

Fast Style Transfer



More results are available at

https://drive.google.com/drive/folders/1_UdU5LzpL6cqPBMNEraBFLCrCvCazN93?usp=sharing.

DeepDream



More results are available at

https://drive.google.com/drive/folders/1OxjmerVDslNgReYpMtsBNFd_qnaxj4dE?usp=sharing

3D Synthesis Results

<https://drive.google.com/drive/folders/1TahNv6sadcNqu5l97LoiPyhs7YFxx7Cd?usp=sharing>

CODE

<https://github.com/n0tafakename/10615-Project-2>

REFERENCE

[1] Müller et al., 2022

Instant Neural Graphics Primitives with a Multiresolution Hash Encoding

<https://github.com/NVlabs/instant-ngp>

[2] B. Mildenhall, P. P. Srinivasan, M. Tancik et al.

NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis

<https://arxiv.org/pdf/2003.08934.pdf>

[3] <https://github.com/futscdav/strotss>

[4] <https://github.com/lengstrom/fast-style-transfer>

[5] <https://github.com/google/deepdream>