

# Neural Reconstruction and Rendering

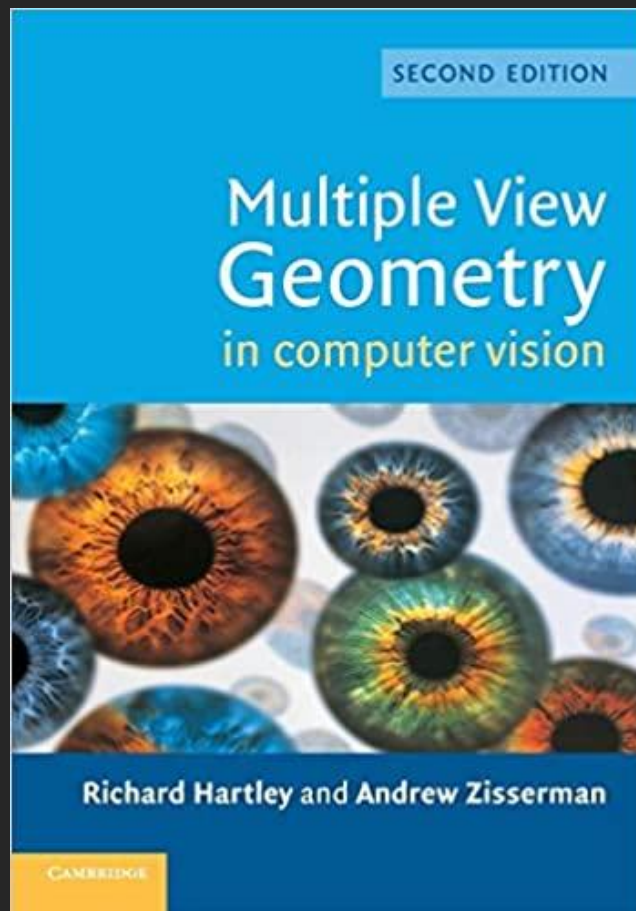
Lan Xu 许岚

ShanghaiTech University

<https://www.xu-lan.com/>

# 1. Traditional Pipeline

# Systematic knowledge with representative methods

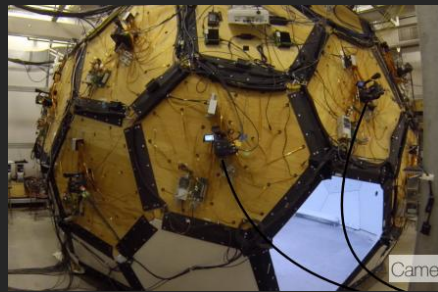
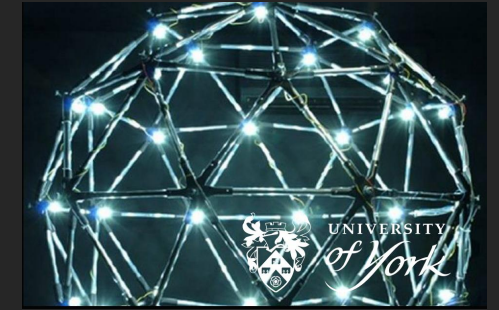


Cambridge University Press,  
March 2004.



**Building Rome in a day**, Sameer Agarwala , Yasutaka Furukawaa , Noah Snavely, Ian Simonb , Brian Curless, Steven M. Seitz and Richard Szeliski, *Communications of the ACM*, 2011

# Well-developed capture devices across the world



Multi-camera Dome

Light stage

Multi-View Stereo

Photometric Stereo

# Various Applications

Yet time-consuming → artist in-the-loop



architecture



digital twin

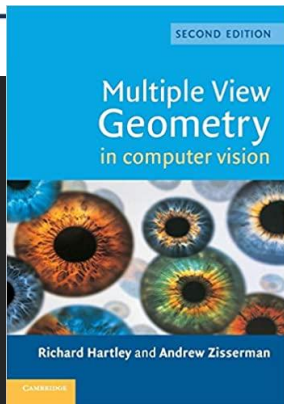
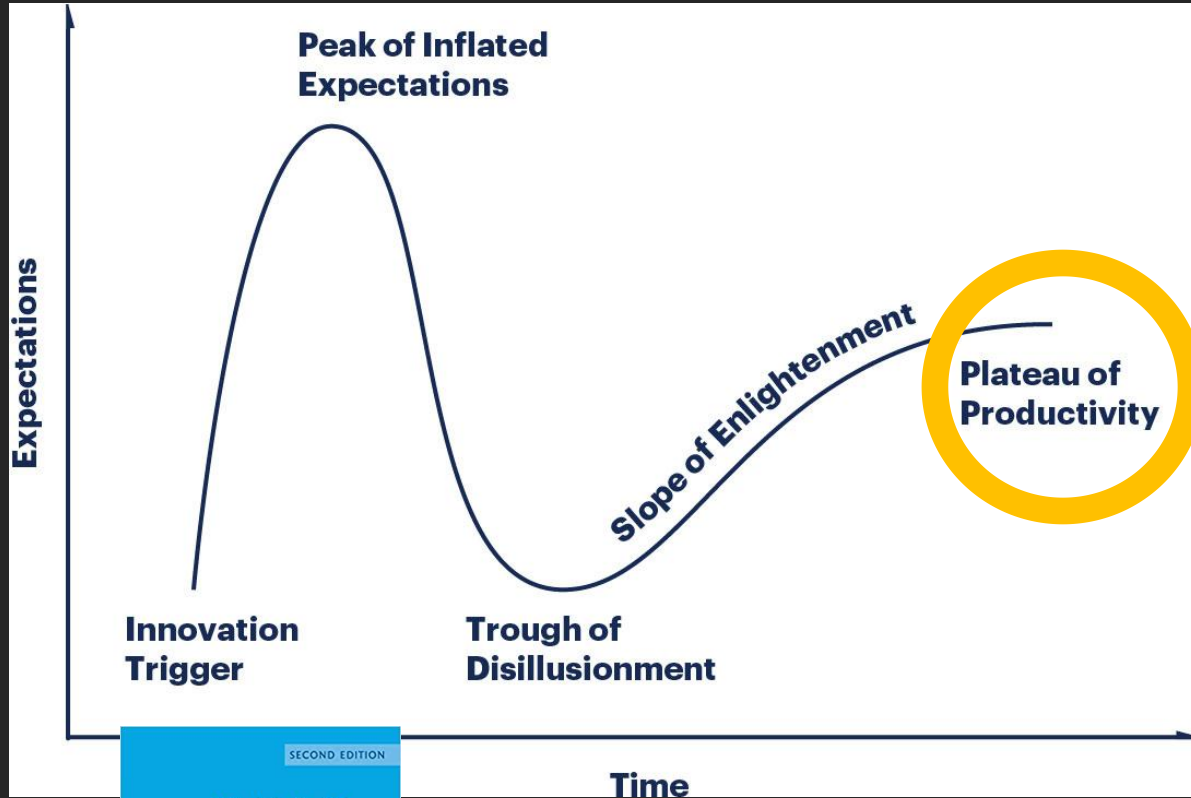


CG / Movie



E-commerce

# Traditional Pipeline: mature in the past decades



2004



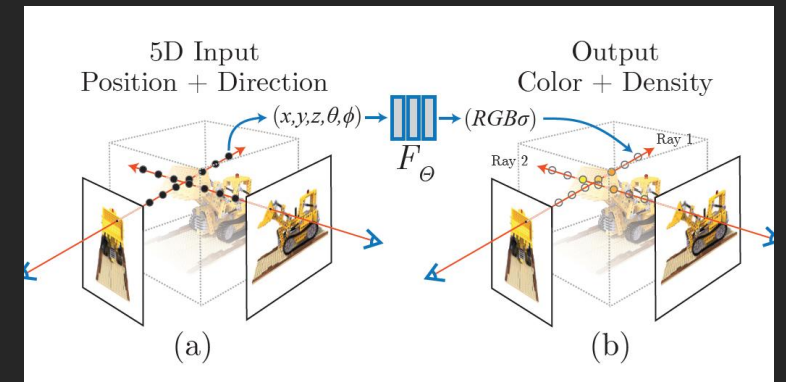
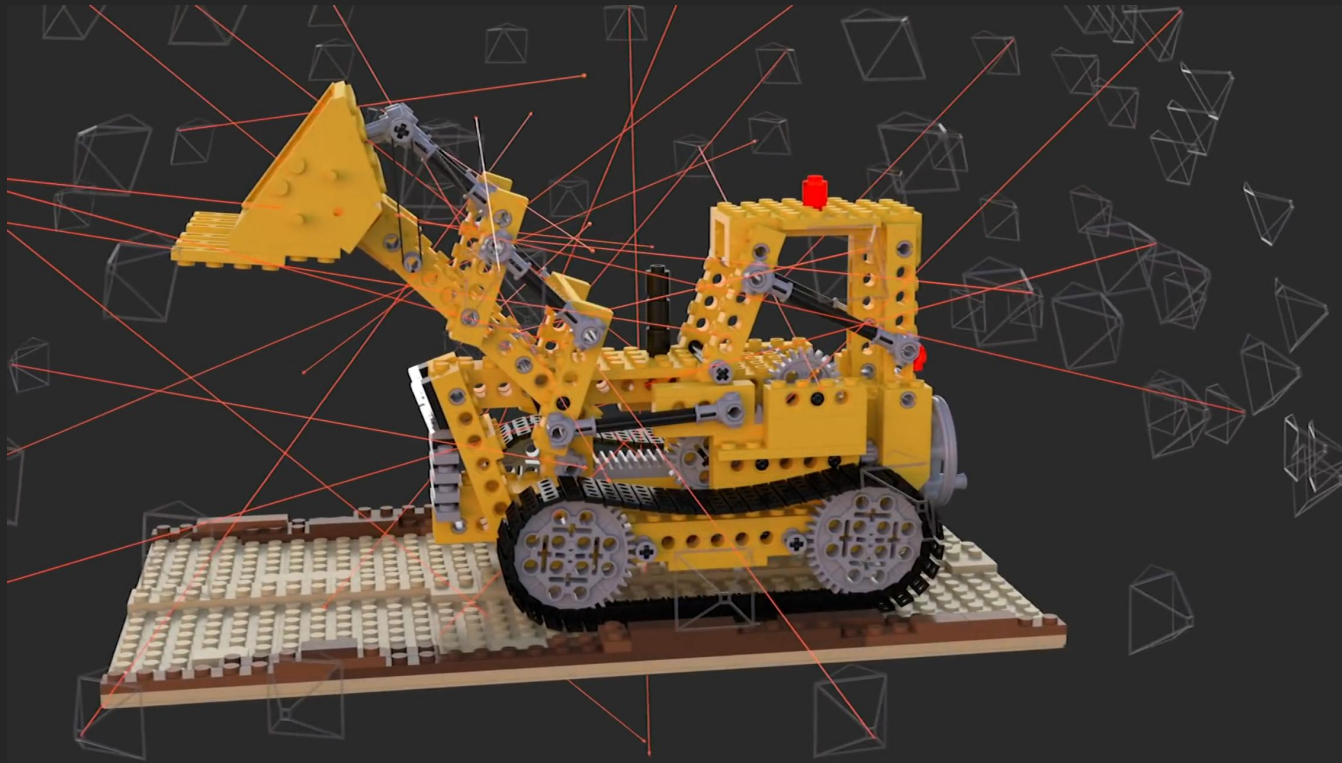
Symbol

2021: Epic Games buys Capturing Reality

## 2. New Trends in the Neural Era

# Neural Radiance Field (NeRF)

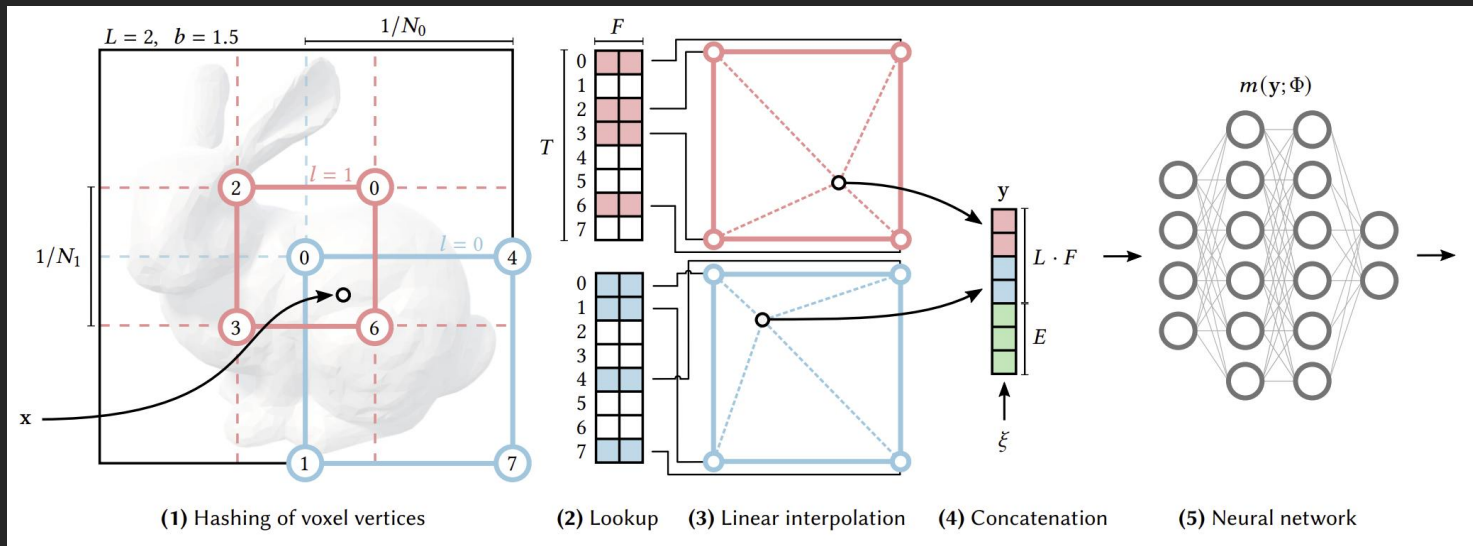
- Color + Density
- Positional Encoding + Volume Rendering



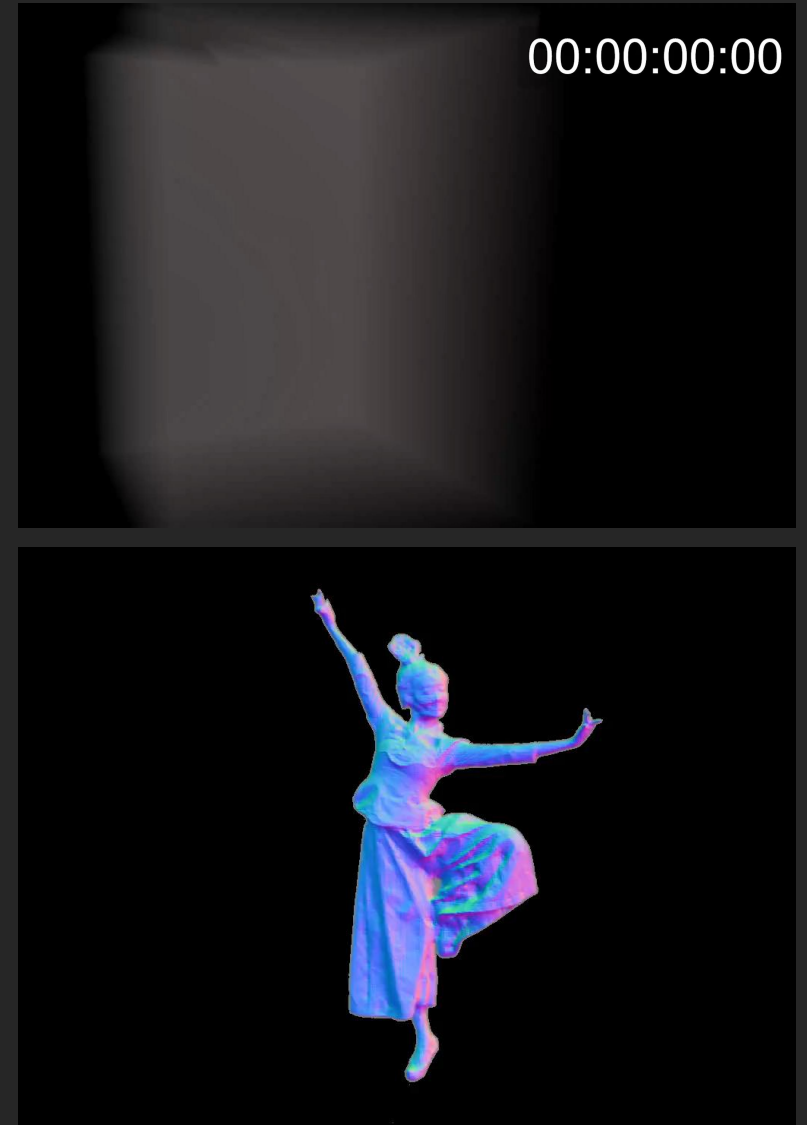
Representing Scenes as Neural Radiance Fields for View Synthesis,  
Mildenhall et al., *ECCV 2020 Oral - Best Paper Honorable Mention*

# Powerful NeRF everywhere

- Reconstruct in seconds
- Multiresolution Hash Encoding



Instant Neural Graphics Primitives with a Multiresolution Hash Encoding, Mildenhall et al., *ACM Transactions on Graphics (SIGGRAPH 2022)*



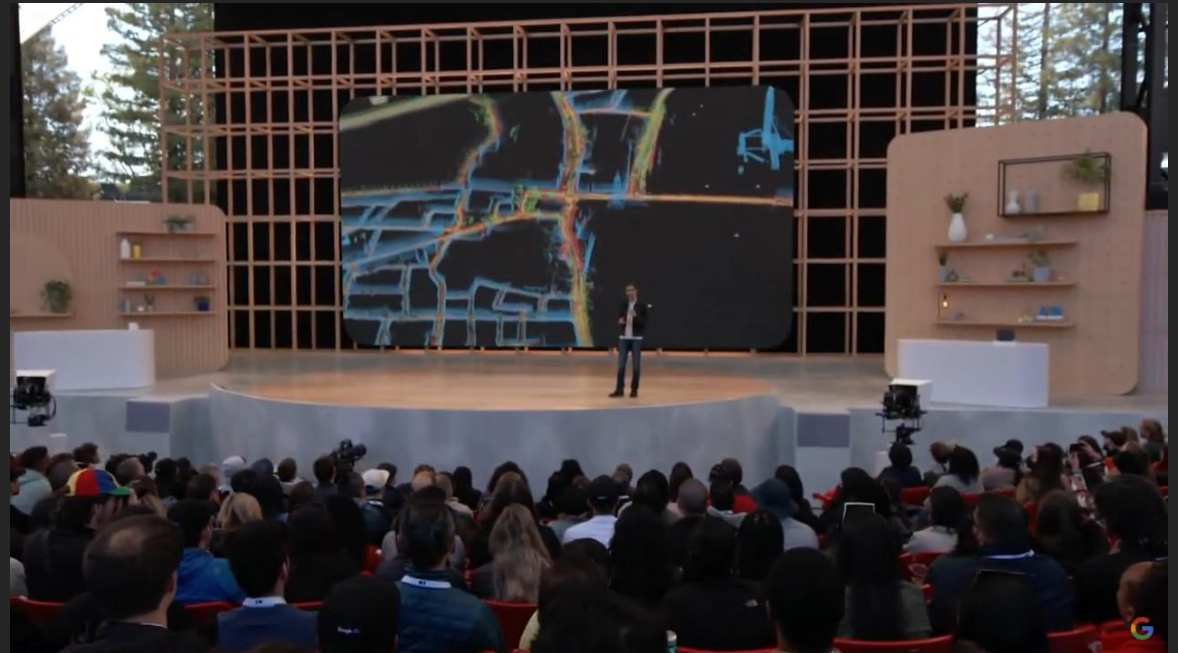
Instant NGP/NeuS

# Powerful NeRF everywhere

- Dynamic or Large-scene



Editable Free-Viewpoint Video using a Layered Neural Representation, Zhang et al., *ACM Transactions on Graphics (SIGGRAPH 2021)*



Block-nerf: Scalable large scene neural view synthesis, Tancik et al., *IEEE CVPR 2022*

First Observation:

Look Good on Poor Reconstruction

# Look Good on Poor Reconstruction: dynamic

- Neural Human Rendering Engine
- Light-weight capture + imperfect geometric attributes



NHR(CVPR2020),  
NeuralHumanFVV(CVPR2021),  
Few-shot NHR (IJCAI2021),  
HumanNeRF (CVPR2022),  
NeuralHOFusion (CVPR2022)

...



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...



# Look Good on Poor Reconstruction: static

- Pleasant visual result even on poor 3D proxy
- Reconstruct -> Render -> Reconstruct



Neural Point-Based Graphics, Aliev et al., *IEEE TPAMI 2021*

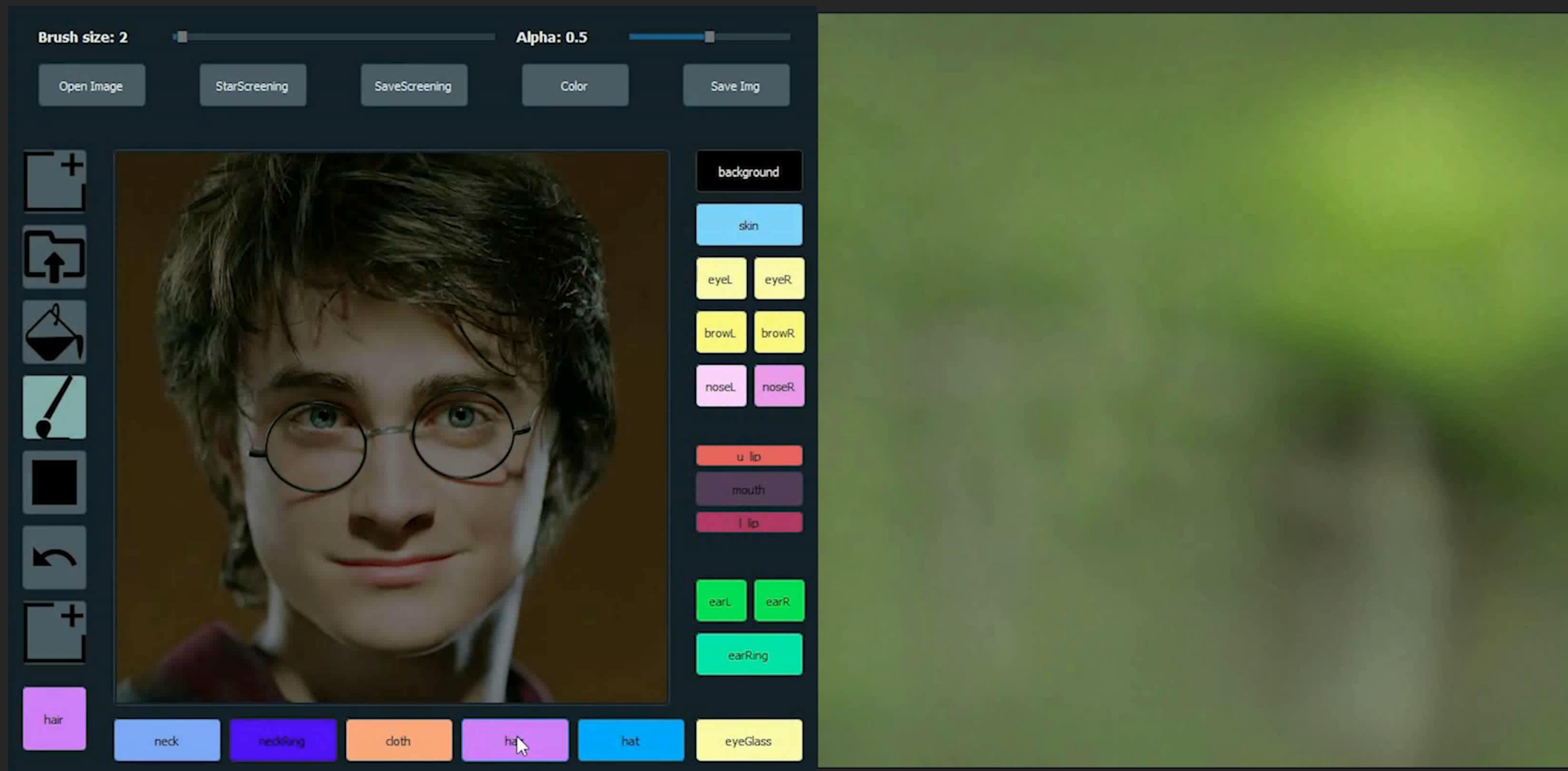


Block-nerf: Scalable large scene neural view synthesis, Tancik et al., *IEEE CVPR 2022*

Second Observation:

Generation rather than Reconstruction

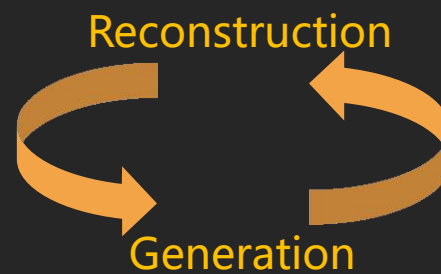
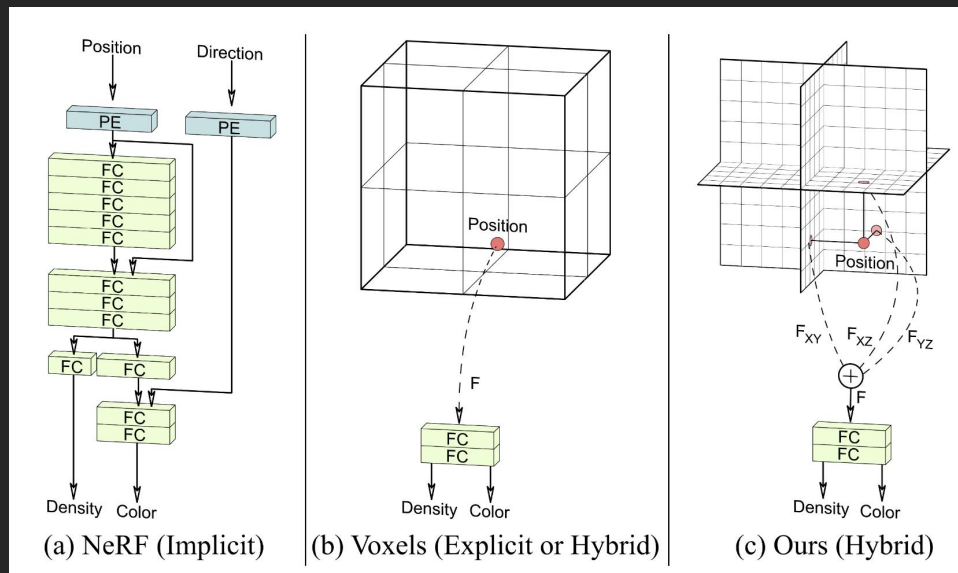
# Generation v.s. Reconstruction: 2D



SofGAN: A Portrait Image Generator with Dynamic Styling, Chen et al.,  
*ACM Transactions on Graphics (TOG, present in SIGGRAPH 2022)*

# Generation v.s. Reconstruction: 3D

- EG3D: Tri-plane features + StyleGAN



Reconstruction as Inversion



More controlled attributes

# Generation v.s. Reconstruction: style

- Stylization meets NeRF
- From re-CONSTRUCT to AI-Generation art



SNeRF: Stylized Neural Implicit Representations for 3D Scenes,  
THU NGUYEN-PHUOC, FENG LIU, and LEI XIAO, *ACM Transactions on Graphics (SIGGRAPH 2022)*

Simon Willison @simonw

New hobby: prototyping video games in 60 seconds using a combination of GPT-3 and DALL-E

Here's "Raccoon Heist"

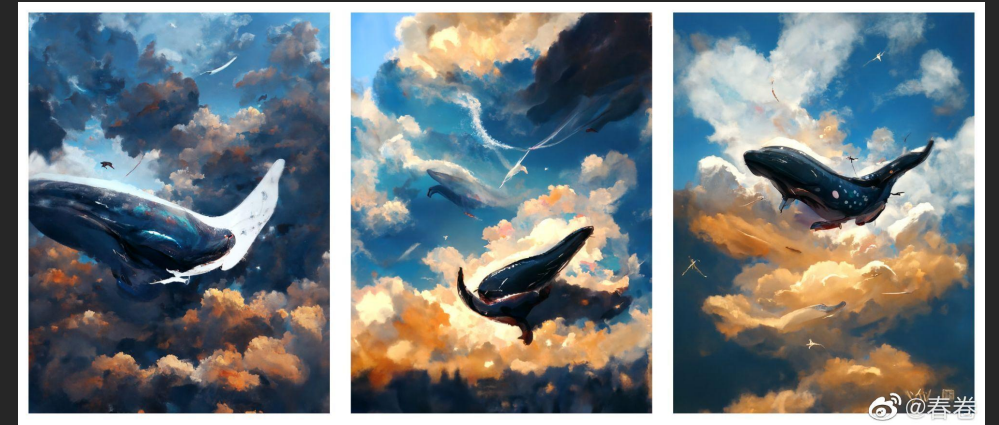
Playground

Load a preset...

Save View code Share ...

Write a detailed product description of a computer game where a team of raccoons go on heists

In "Raccoon Heist", you and your team of thieving raccoons are tasked with pulling off a series of daring heists. From robbing banks to stealing priceless art, no job is too big or too small for your furry crew. You'll need to use your wits and your skills to avoid the police and make a clean getaway with the loot. With exciting gameplay and a charming cast of characters, "Raccoon Heist" is

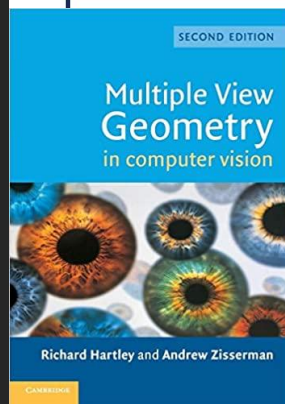
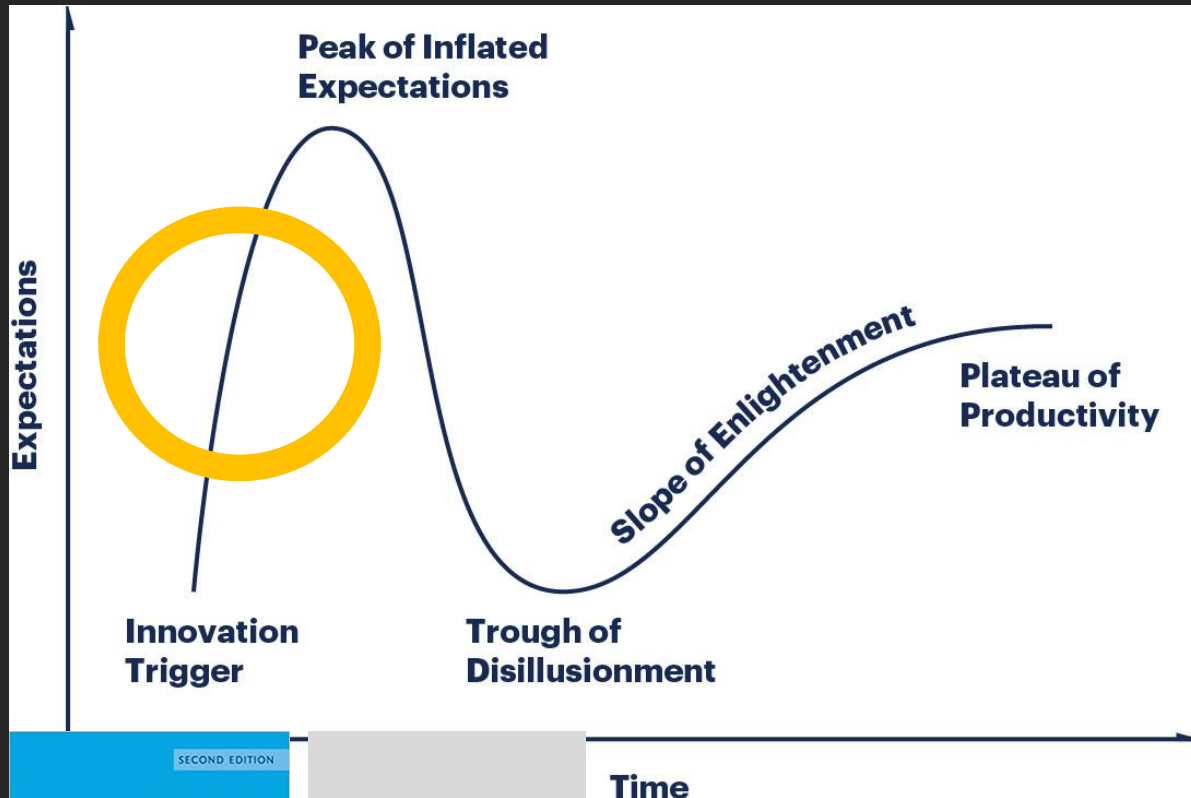


Generation with "whale in the sky"  
GPT-3 + DALL · E

Third Observation:

Where are we standing?

# Where are we standing?



- Research
  - Still exploding
  - Systematic → new textbook for next decades
- Symbolized Applications
  - NeRF as a new type of media
  - Compatibility
  - Codec, Sharing, Cloud-Render?

# ShanghaiTech for Neural Modeling & Rendering

To see is to believe; To believe is to see



The end, thanks for listening!