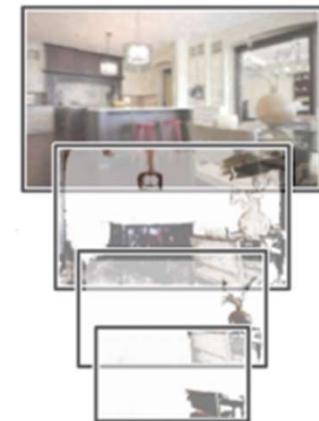
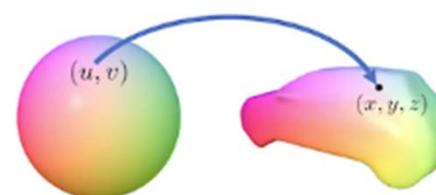
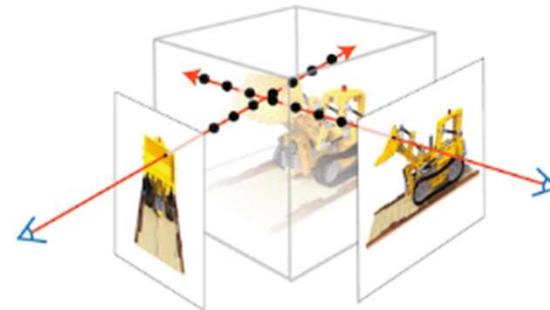


# 三维视觉：图像和图形

## 3D Vision: Graphics meets Vision



# Today's Topics

- What is 3D Vision?
- Why 3D Vision?
- What will be learned?

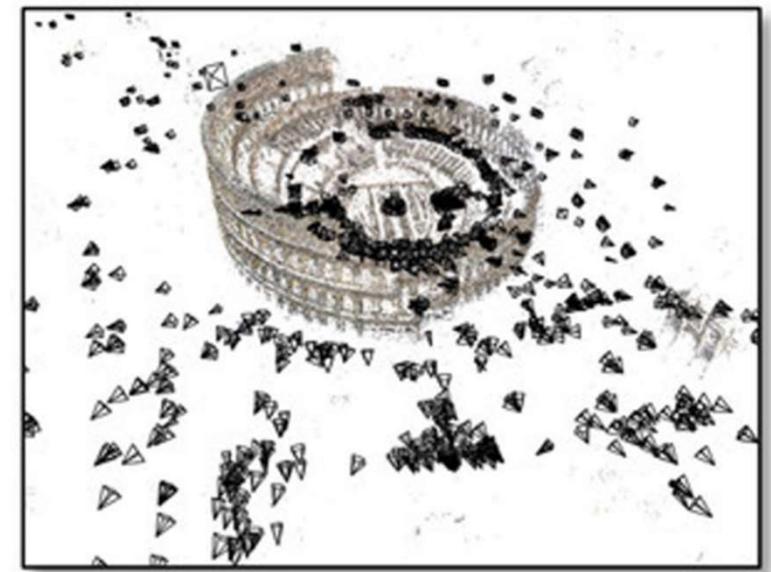
# What's 3D Vision?

Vision ←→ 3D

# What's 3D Vision?



Reconstruction



Vision

3D

# What's 3D Vision?



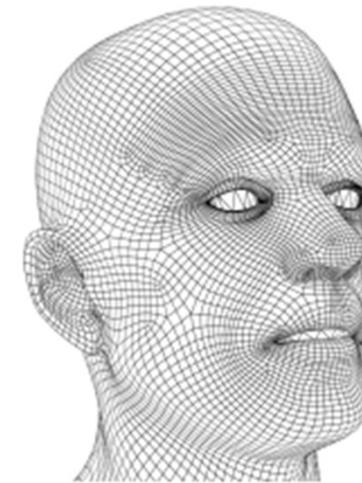
Vision

3D

# What's 3D Vision?



Rendering



Vision

3D

# What's 3D Vision?



Rendering



Vision

3D

# What's 3D Vision?

Render new views



Reconstruction by  
(Differentiable)  
Rendering



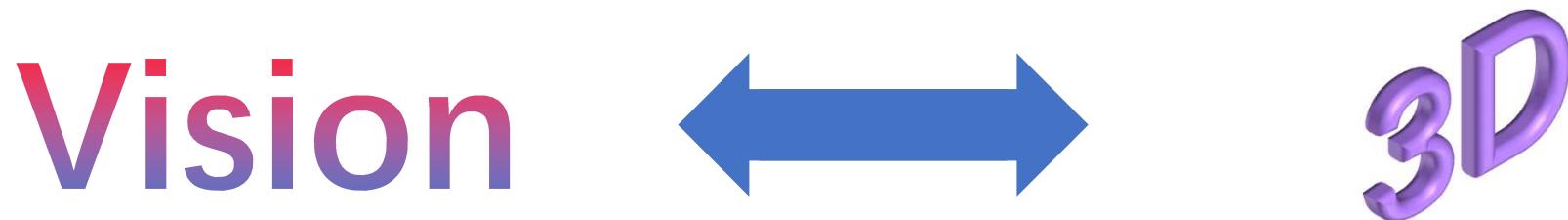
Optimize NeRF



Vision

3D

# What's 3D Vision?



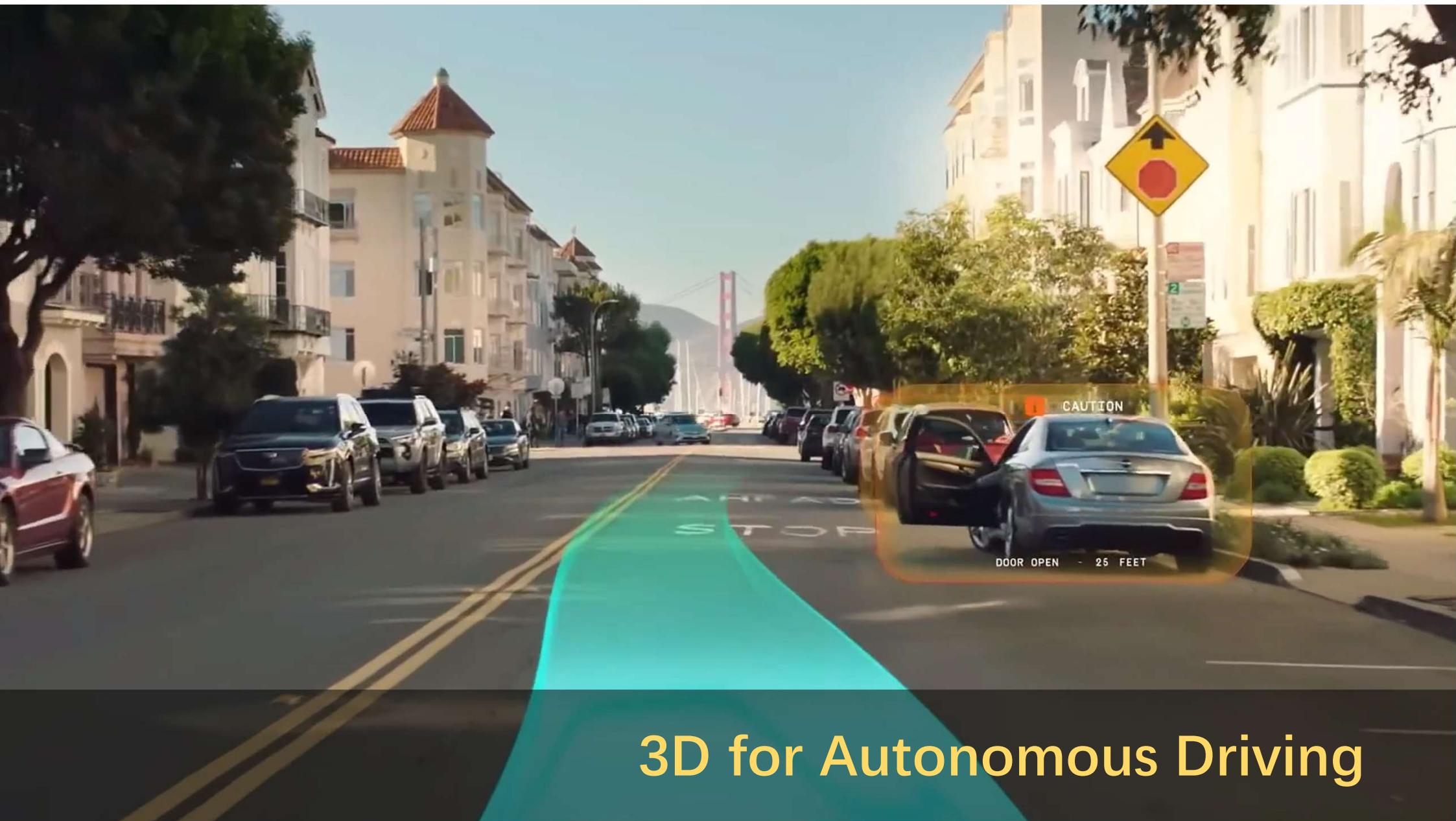
- Two directions: Reconstruction & Rendering
  - Many tasks utilize both directions
- Various kinds of Vision & 3D Representation

# Today's Topics

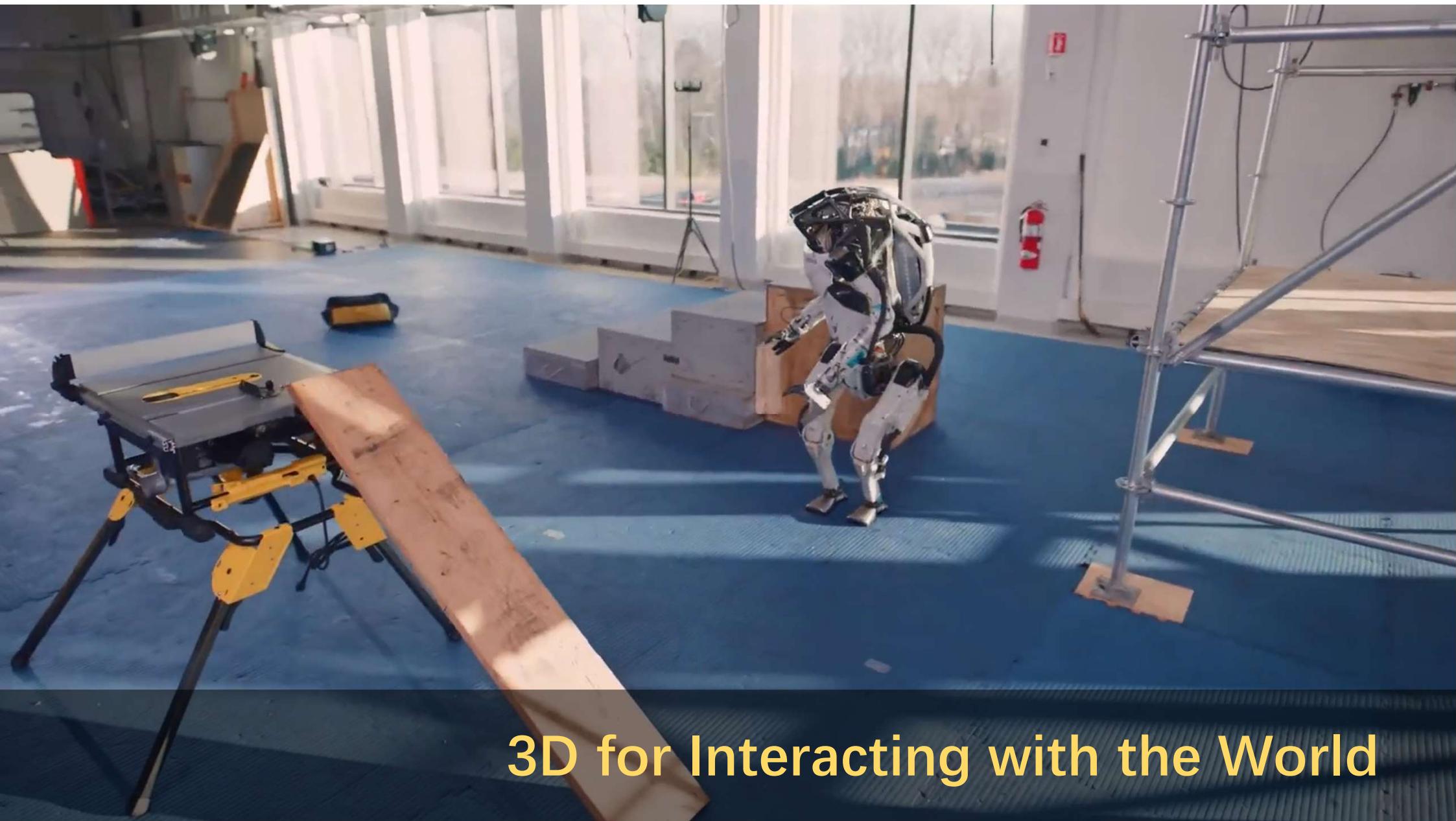
- What is 3D Vision?
- Why 3D Vision?
- What will be learned?

# We live in a (Dynamic) 3D World





3D for Autonomous Driving



3D for Interacting with the World

THE ASSOCIATED PRESS



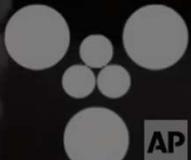
SPEED 0 KM/H  
ALTITUDE 0 KM  
LOX  
CH4

LIVE 1.11M VIEWS

T+00:06.56  
STARSHIP FLIGHT TEST

SPEED 17502 KM/H  
ALTITUDE 144 KM  
LOX  
CH4

3D for Rocket Landing





3D for Gaming and Arts



3D for Immersive Memories

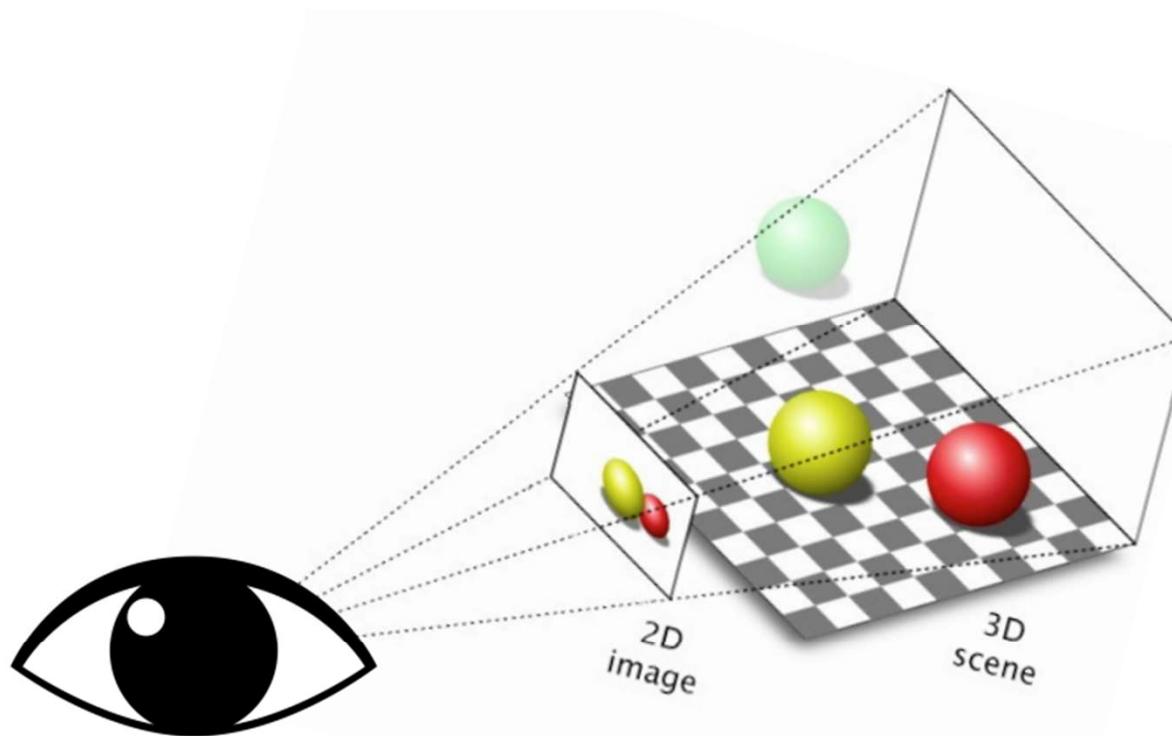


3D for Remote Communication

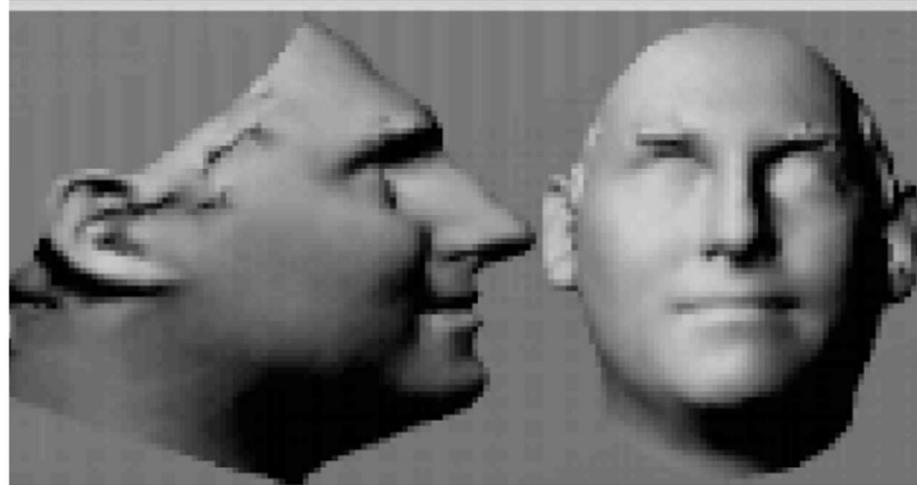
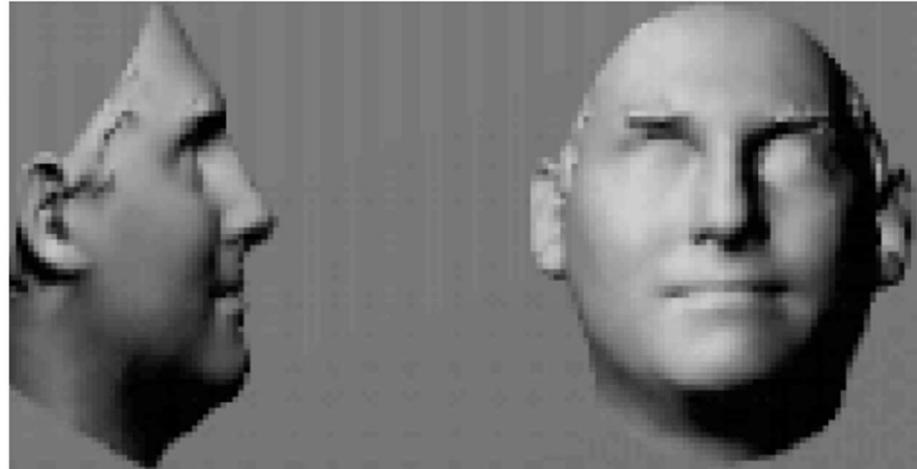
Why 3D Vision Important?

Why 3D Vision Challenging?

# We (and our cameras) see the 3D world from 2D



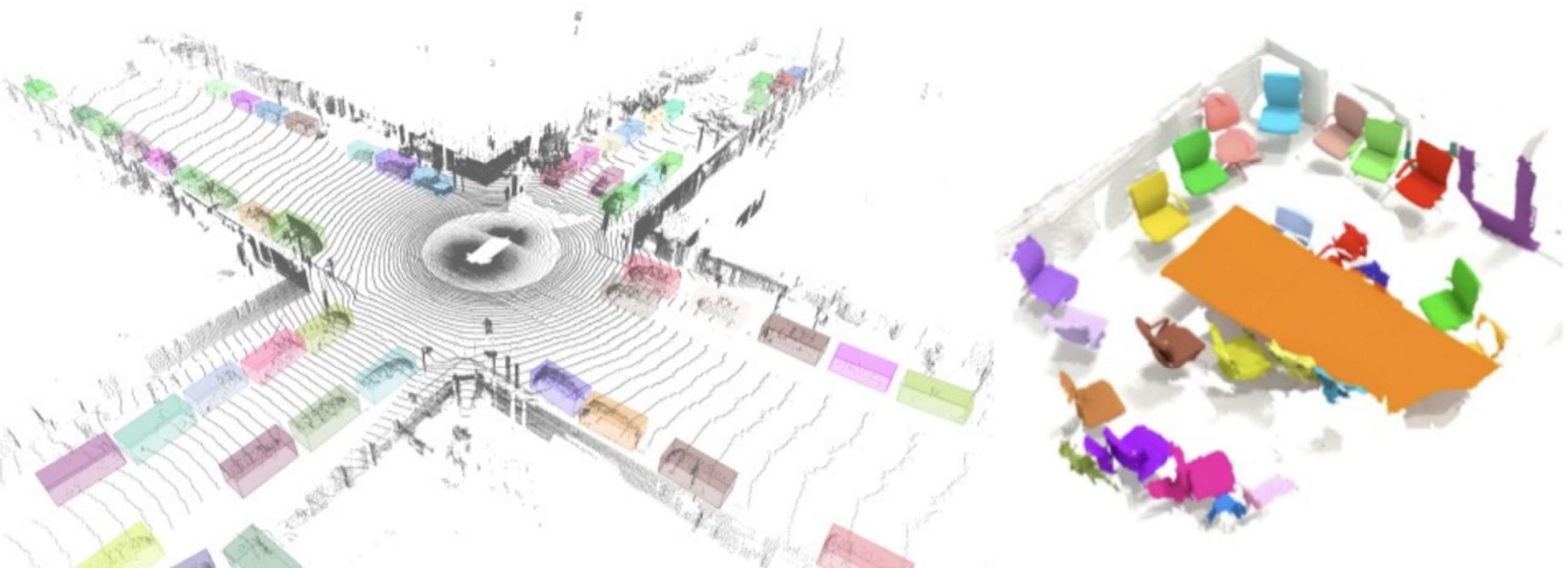
# The problem is ill-posed



# Real & Image



# We also need semantics 3D world



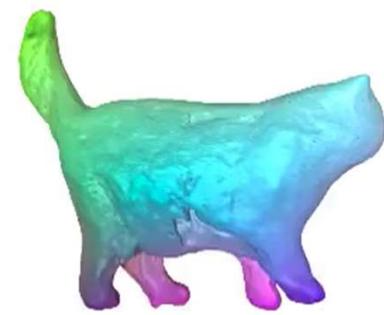
# And handle many other factors.



Illumination



Materials



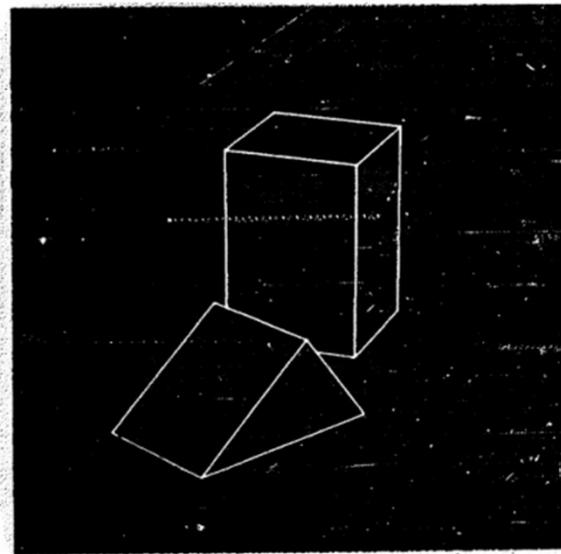
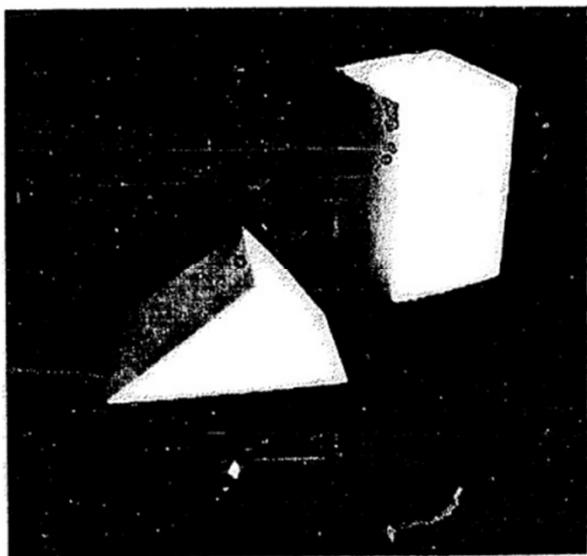
Dynamics and Motion

MACHINE PERCEPTION OF THREE-DIMENSIONAL SOLIDS

by

LAWRENCE GILMAN ROBERTS

Submitted to the Department of Electrical Engineering  
on May 10, 1963, in partial fulfillment of the require-  
ments for the degree of Doctor of Philosophy.



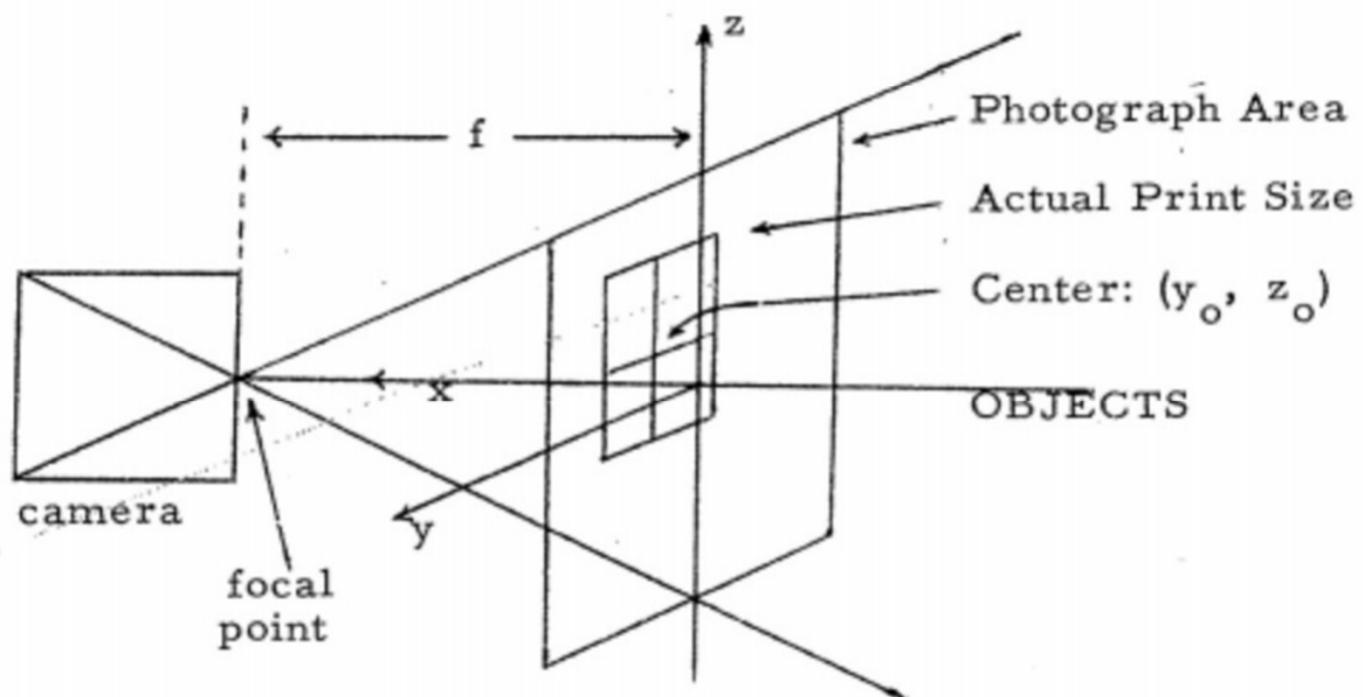


Figure 1: Camera Transformation

# The Lumigraph

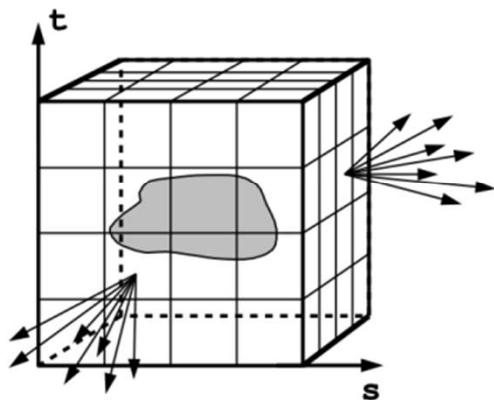


Figure 1: The surface of a cube holds all the radiance information due to the enclosed object.

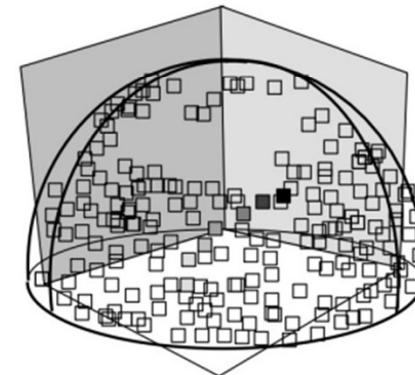


Figure 11: The user interface for the image capture stage displays the current and previous camera positions on a viewing sphere. The goal of the user is to “paint” the sphere.

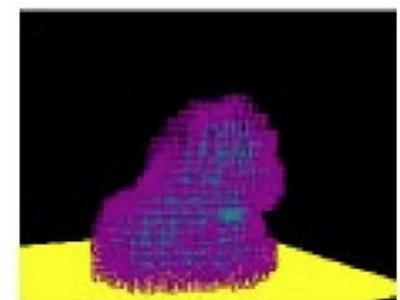
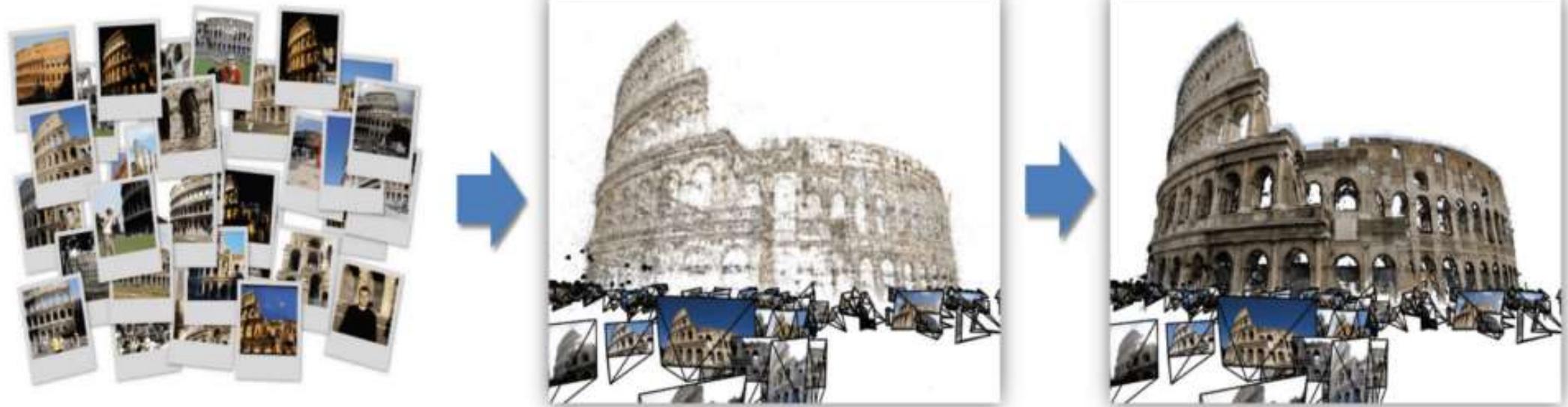


Figure 12: Segmented image plus volume construction

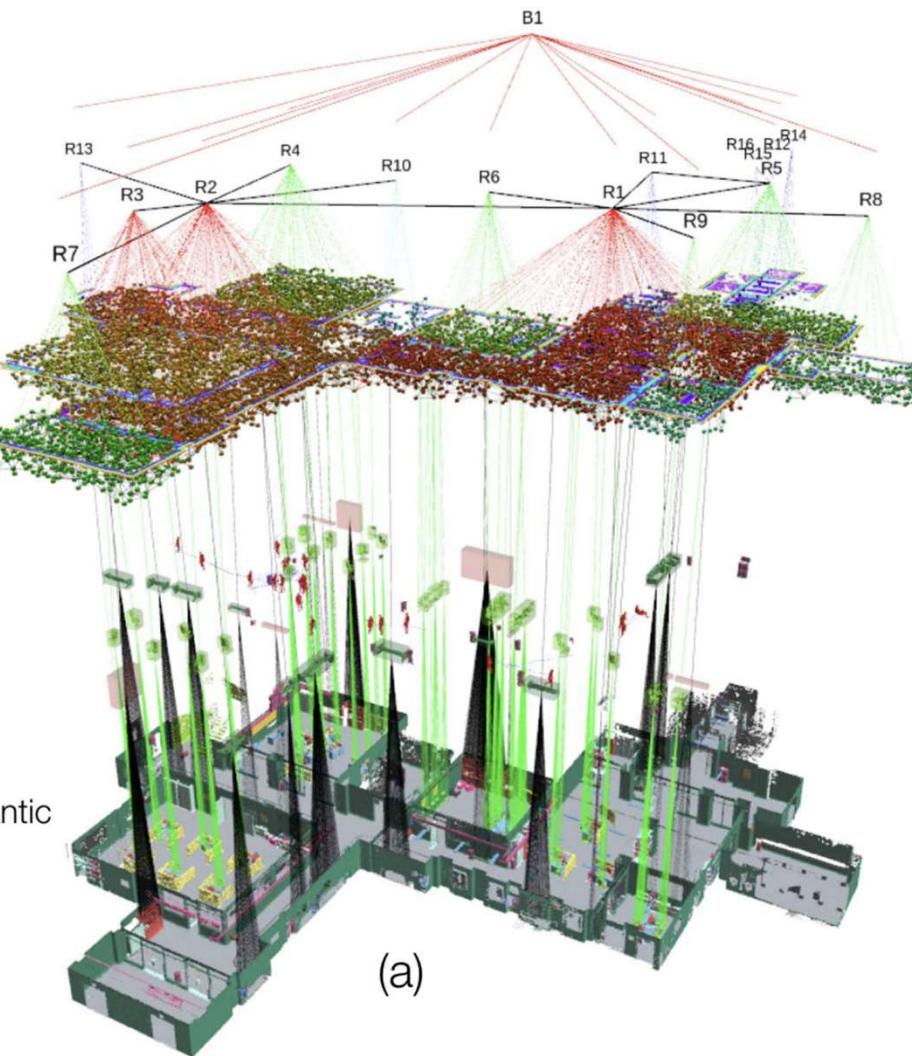
# Building Rome in a Day



Building Rome in a Day. ICCV 2009.

# 3D Perception

**Layer 5:**  
Buildings

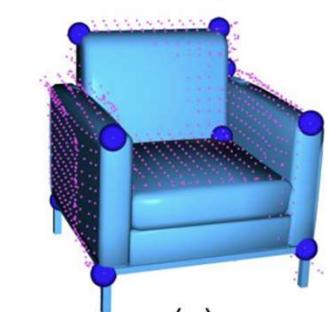


**Layer 4:**  
Rooms

**Layer 3:**  
Places and  
Structures

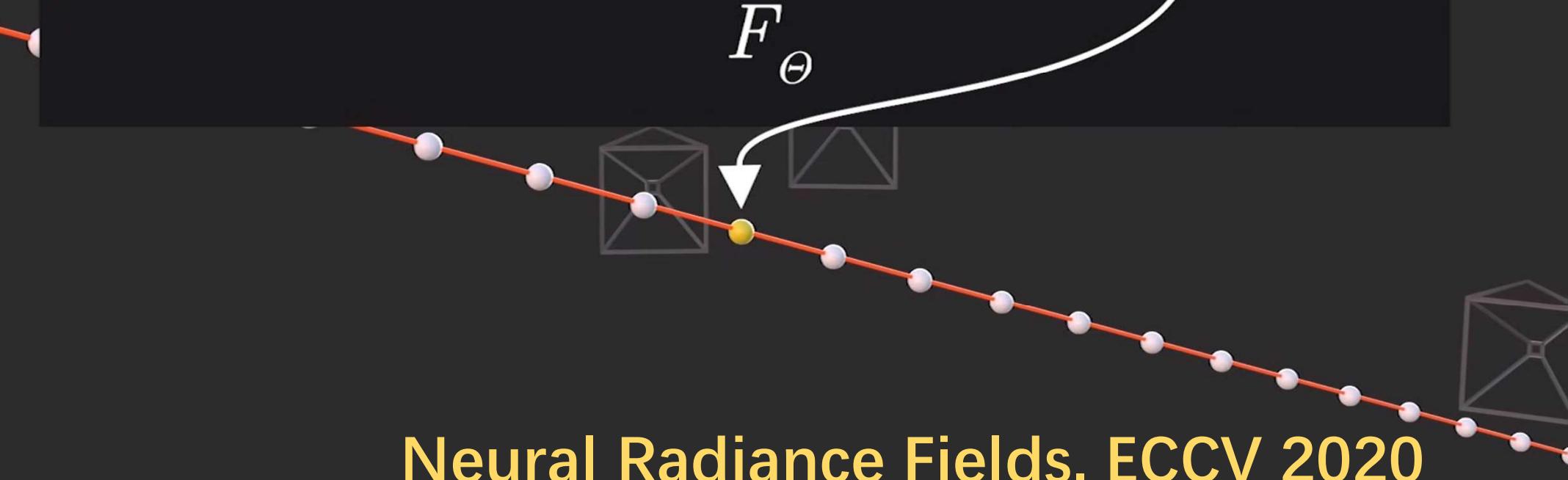
**Layer 2:**  
Objects and  
Agents

**Layer 1:**  
Metric-Semantic  
Mesh



3D Dynamic Scene Graphs: Actionable Spatial Perception with Places, Objects, and Humans. RSS 2020.

$(x, y, z, \theta, \phi) \rightarrow F_{\Theta} \rightarrow (RGB\sigma)$



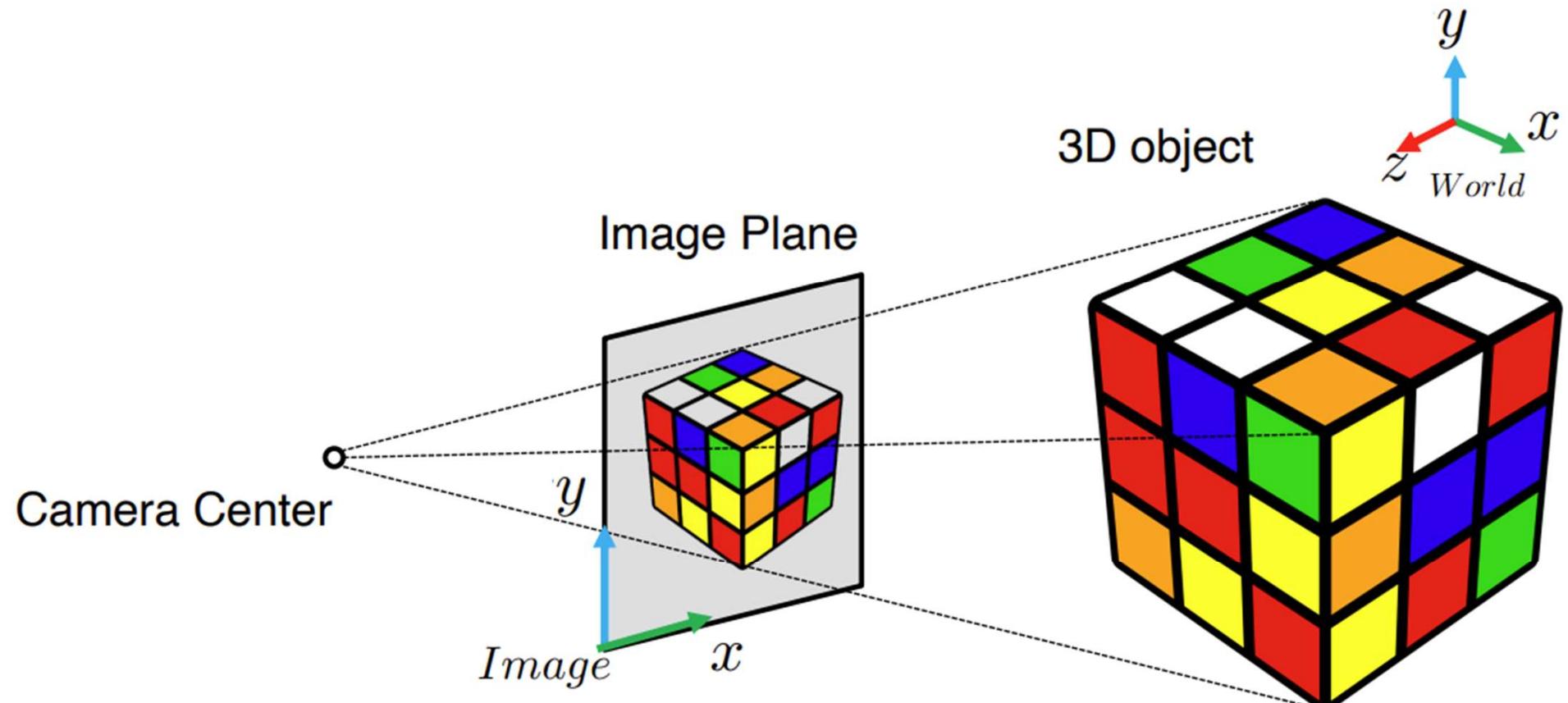


Zip-NeRF: Anti-Aliased Grid-Based Neural Radiance Fields. ICCV 2023.

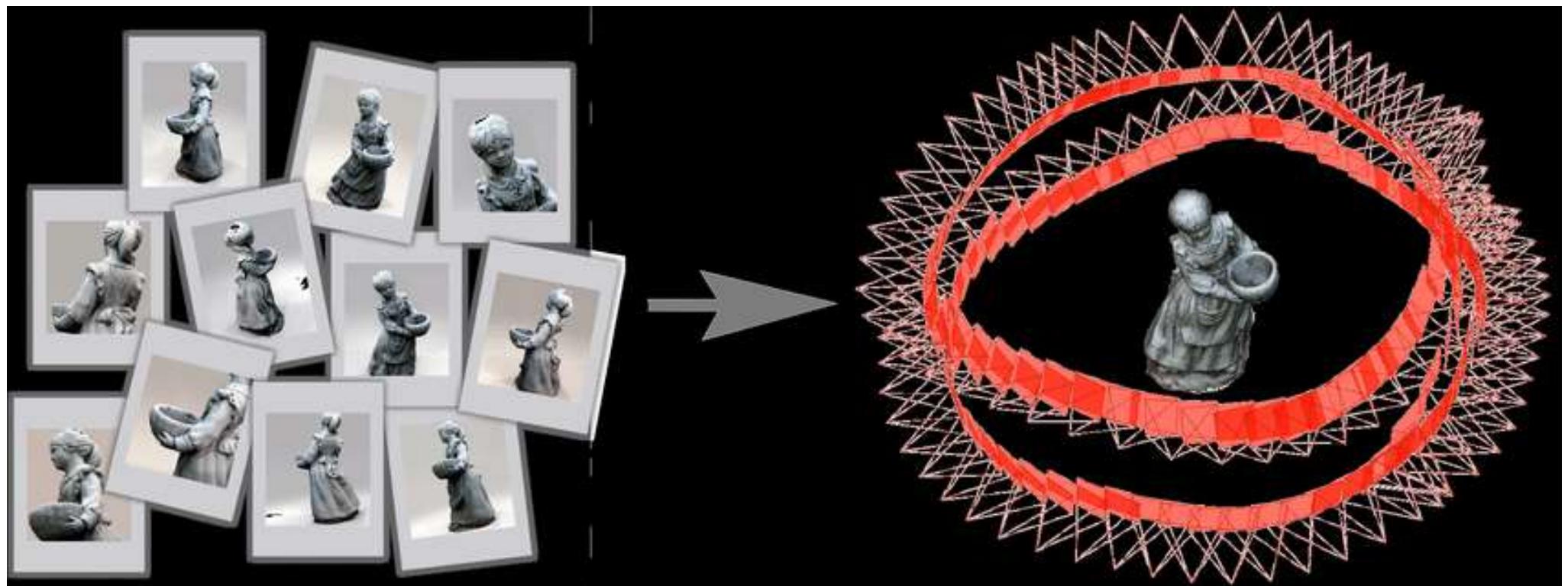
# Today's Topics

- What is 3D Vision?
- Why 3D Vision?
- What will be learned?

# 3D Vision Fundamental: Camera Models



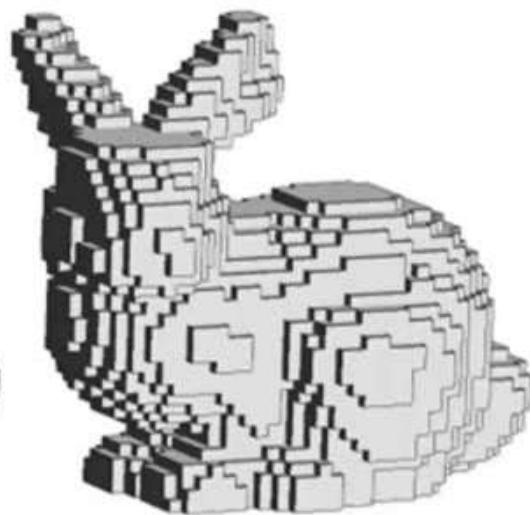
# 3D Modeling from Multi-views



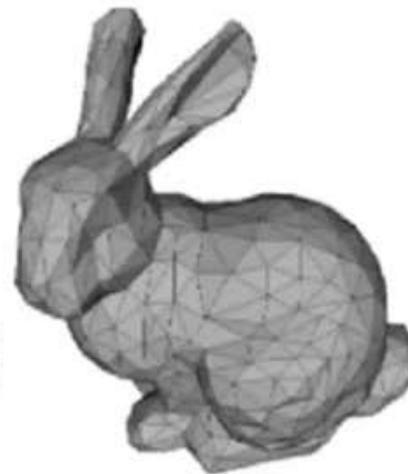
# 3D Representations & Rendering



Point Clouds

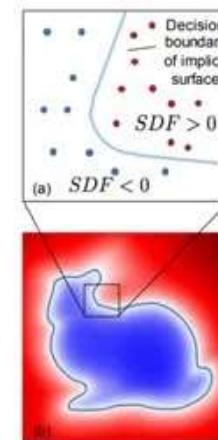


Voxel Grids



Triangle Mesh

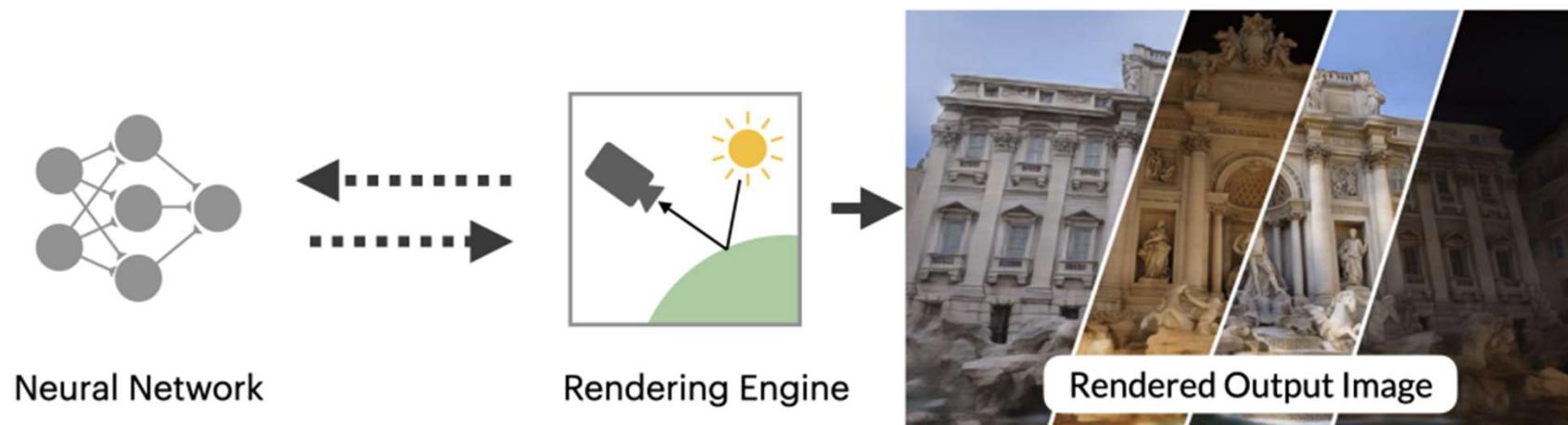
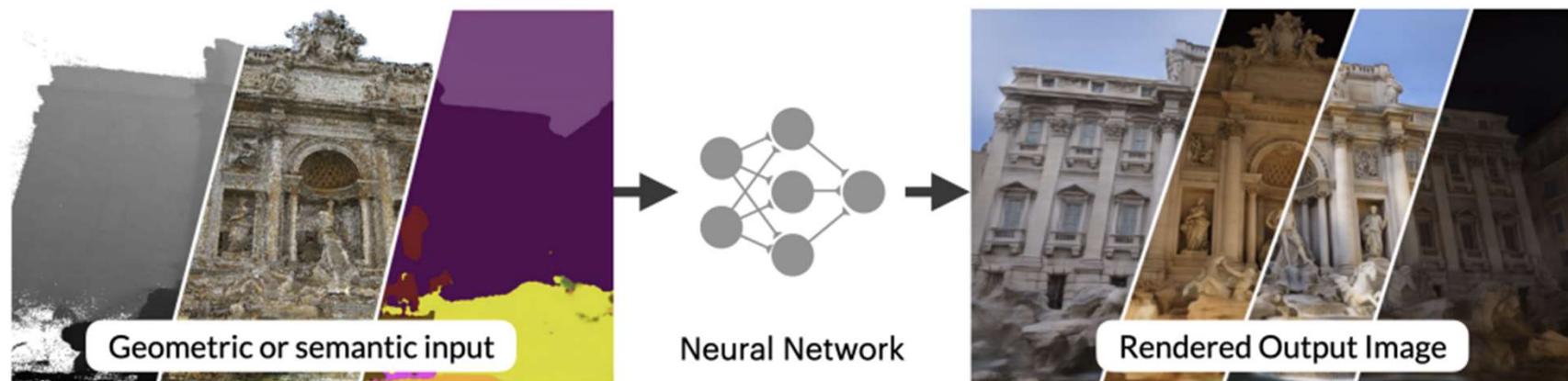
Explicit



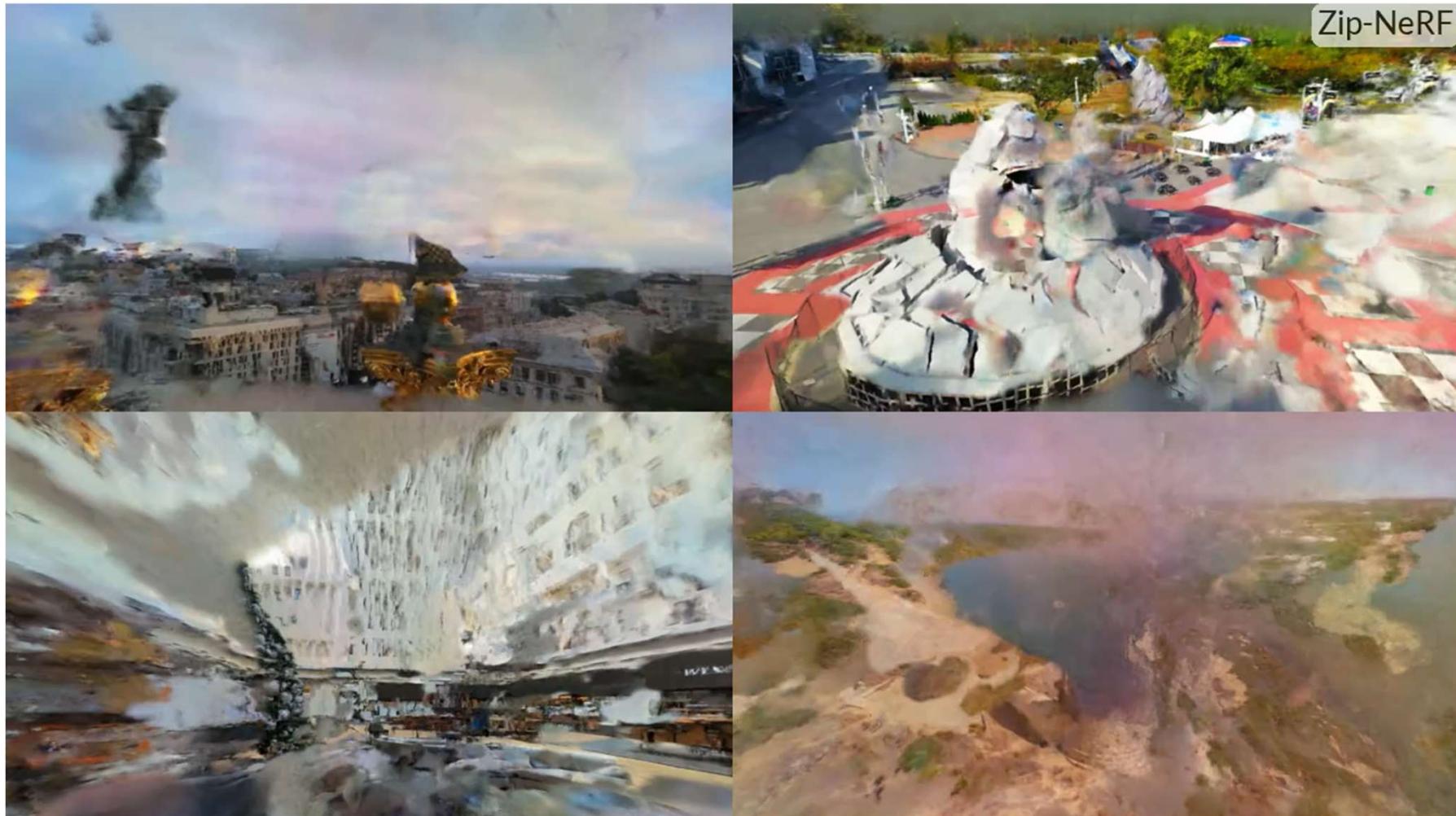
Signed Distance Field

Implicit

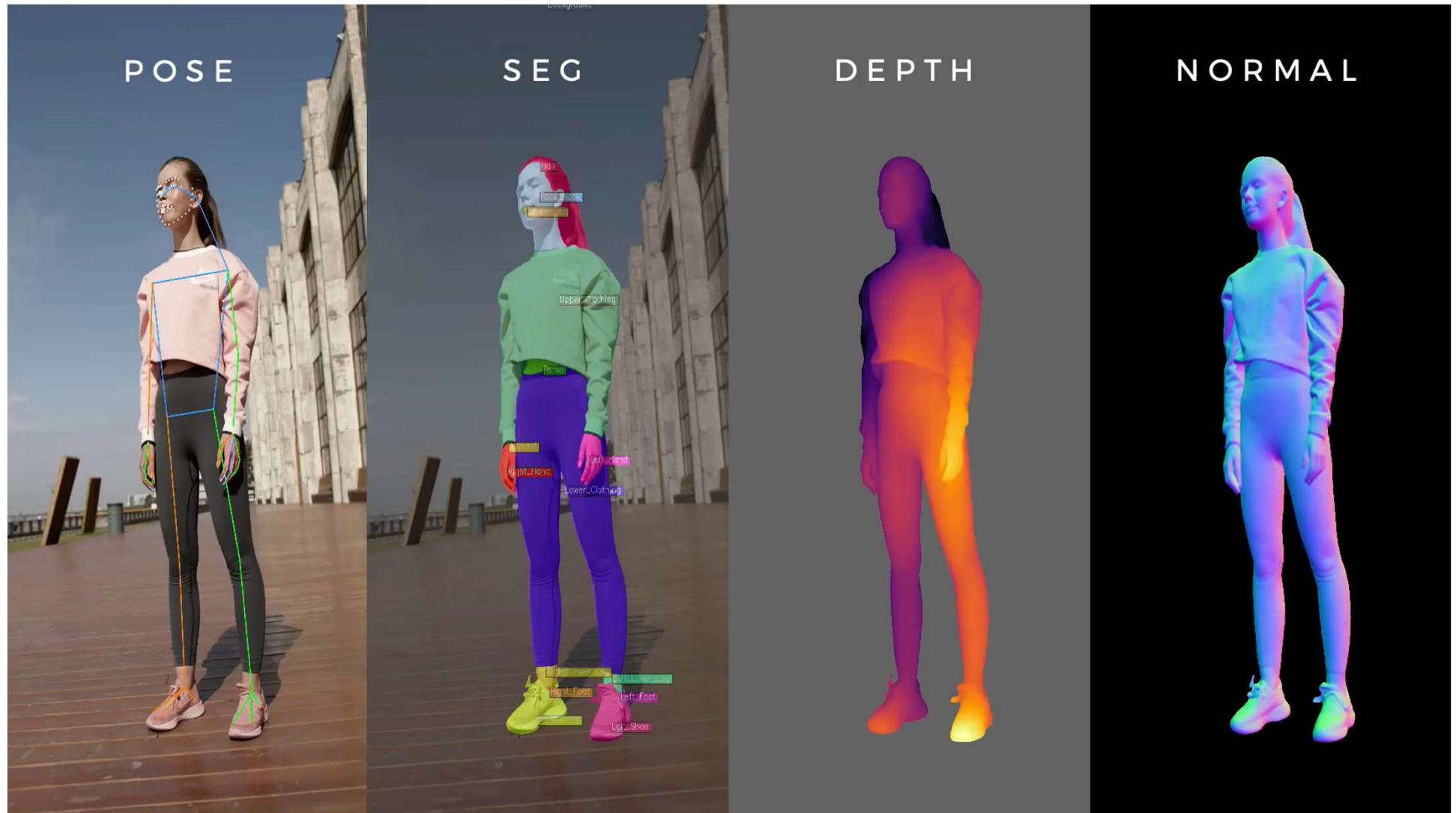
# Differentiable and Neural Rendering



# Single/Few-Shot 3D

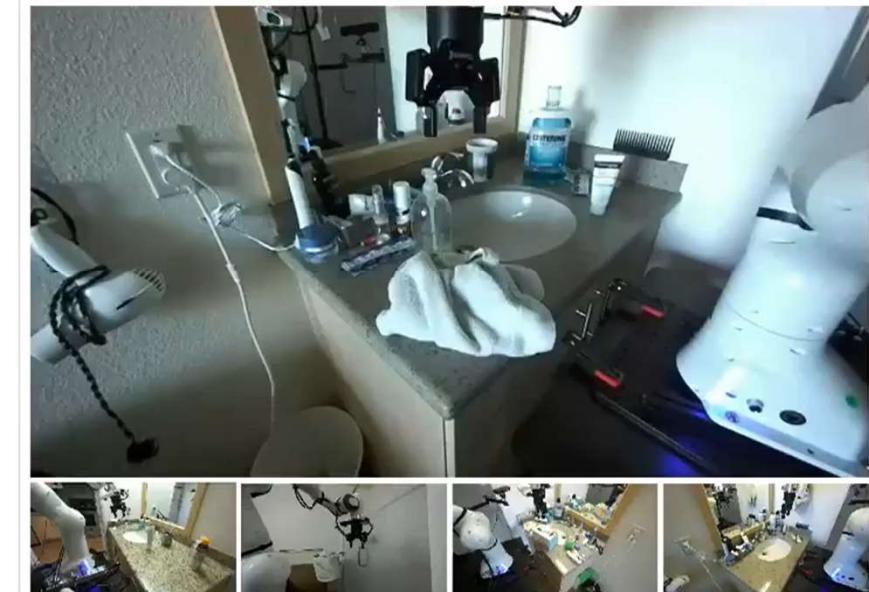


# Dynamic 3D (4D)



# 3D Perception: Sense, Understand and Interact

Bathroom



## DROID

**Distributed Robot Interaction Dataset**

- 76k** Episodes
- 564** Scenes
- 52** Buildings
- 13** Institutions
- 86** Tasks / Verbs

Kitchen



Dining Room



Bedroom



Laboratory



Laundry Room



Office





中国科学技术大学

University of Science and Technology of China

谢谢观看！