

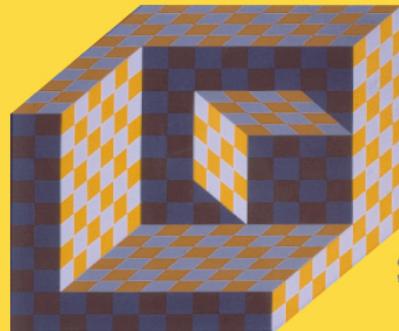


INTERDISCIPLINARY APPLIED MATHEMATICS

IMAGING, VISION, AND GRAPHICS

An Invitation to 3-D Vision

From Images to Geometric Models



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Springer



Lecture 1

Overview and Introduction



Reconstruction from images – The Fundamental Problem

Input: Corresponding “features” in multiple perspective images.

Output: Camera pose, calibration, scene structure representation.





Reconstruction from images – The Fundamental Problem

“Rome wasn’t built in a day.”



APPLICATIONS – Autonomous Highway Vehicles (1990-)

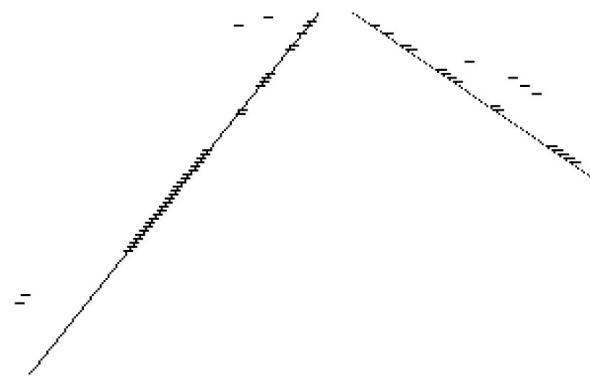
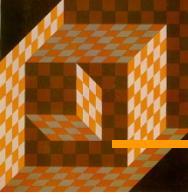


Image courtesy of California PATH

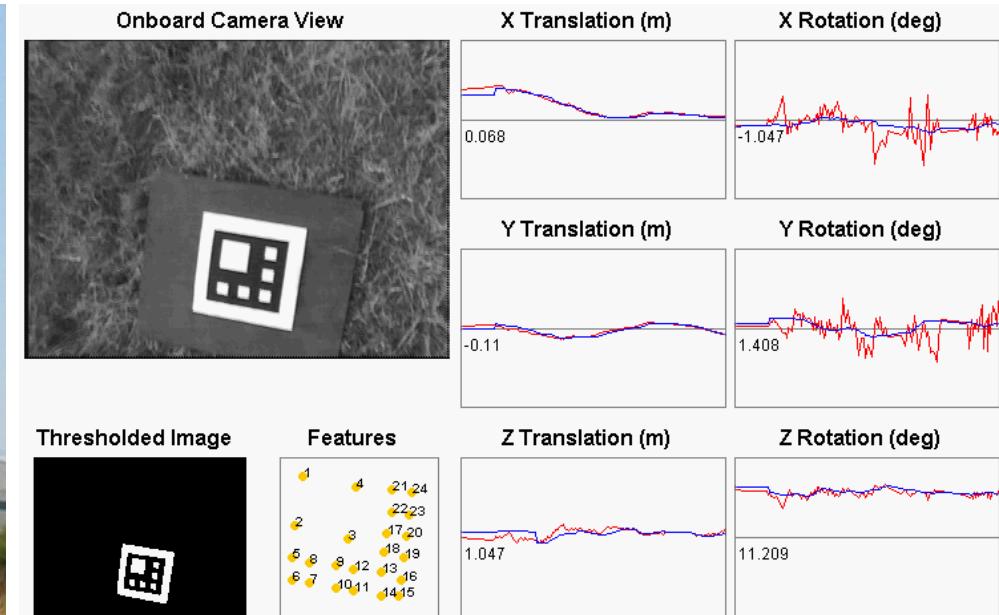


APPLICATIONS – Today Autonomous Vehicles

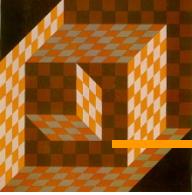




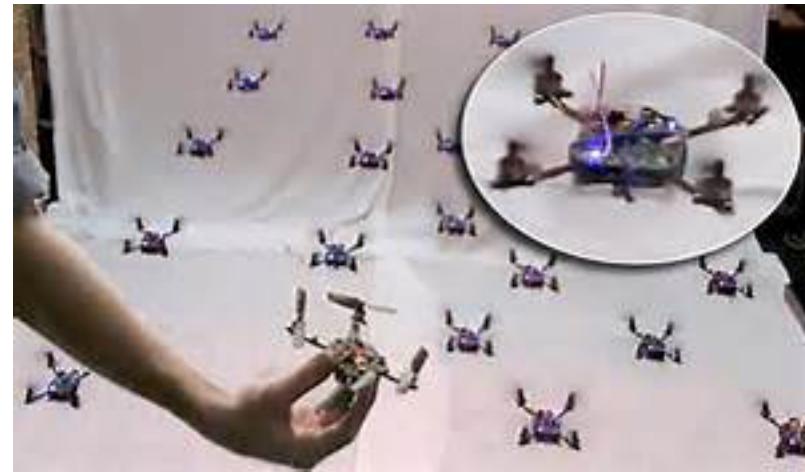
APPLICATIONS – Unmanned Aerial Vehicles (UAVs, 1998)



Rate: 10Hz; Accuracy: 5cm, 4°

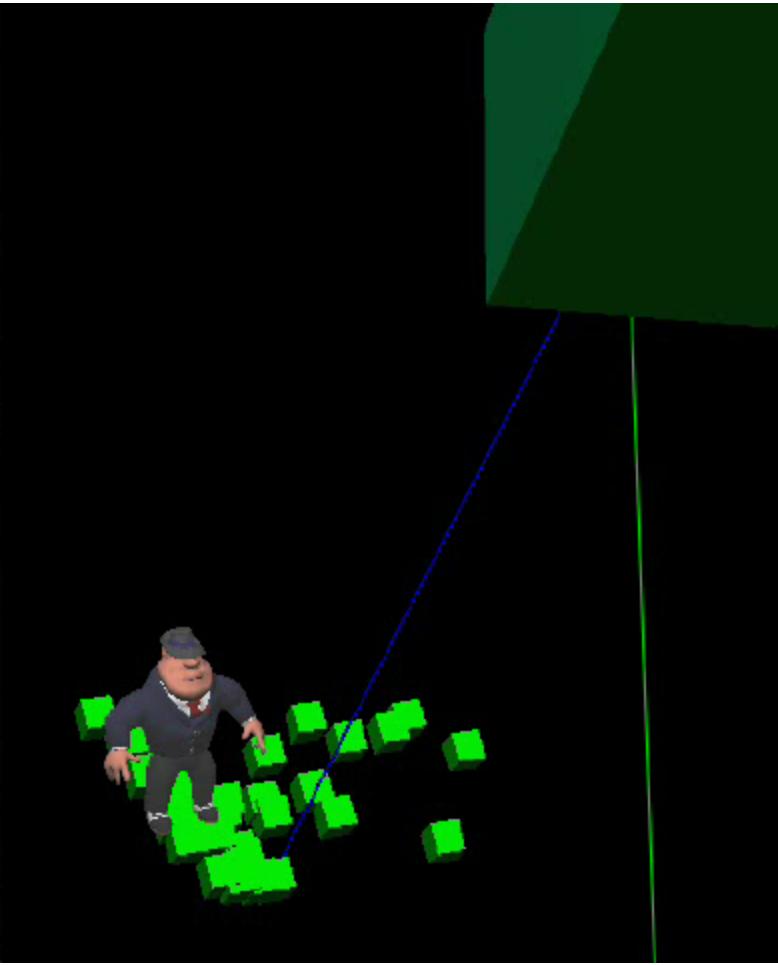


APPLICATIONS – Today Unmanned Aerial Vehicles (UAVs)





APPLICATIONS – Real-Time Virtual Object Insertion

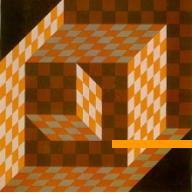




APPLICATIONS – Real-Time Sports Coverage

First-down line and virtual advertising





Virtual Museum on Your Phone

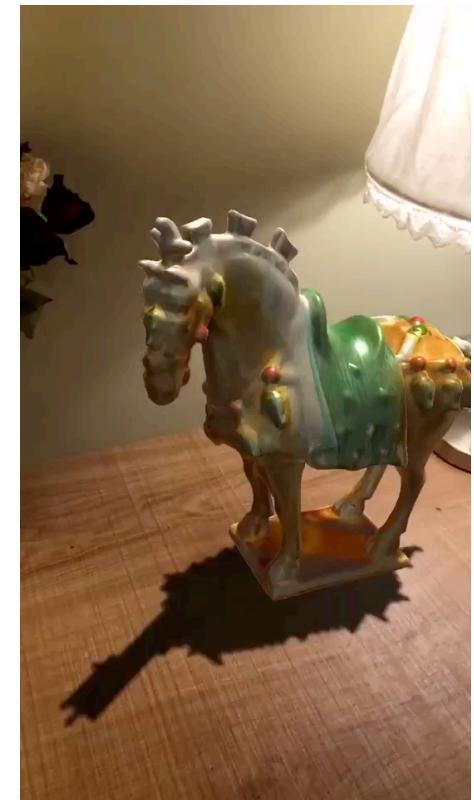
Multi-camera
Light stage



Shanghai Museum Items

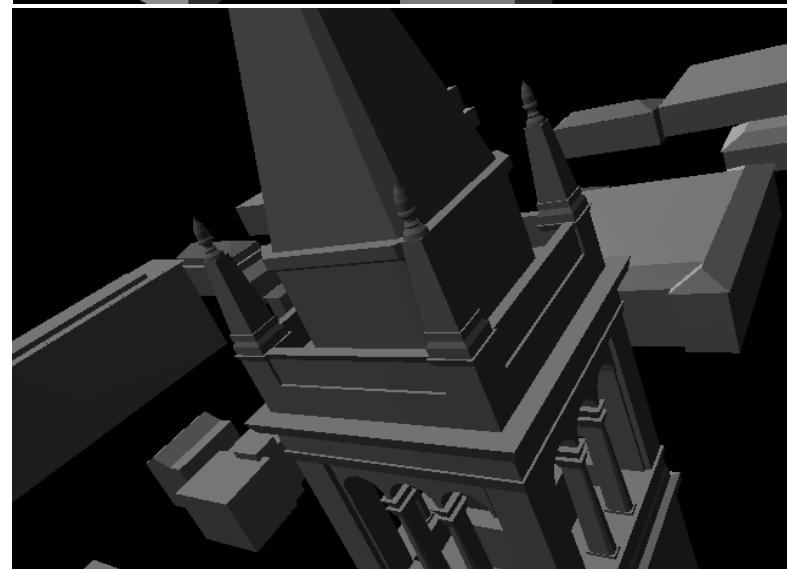
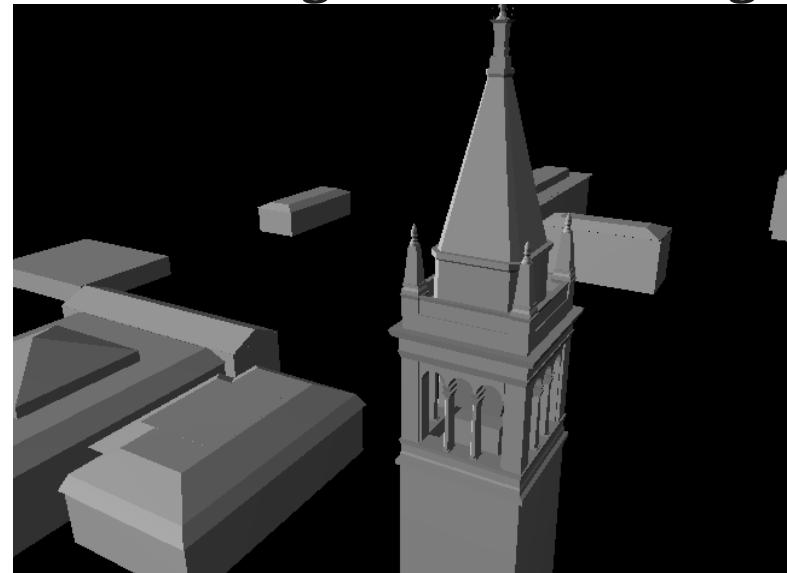


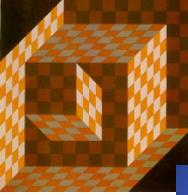
On iPhone VR kit





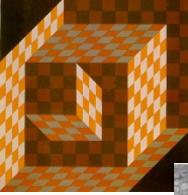
APPLICATIONS – Image Based Modeling and Rendering





APPLICATIONS – Image Alignment, Mosaicing, and Morphing





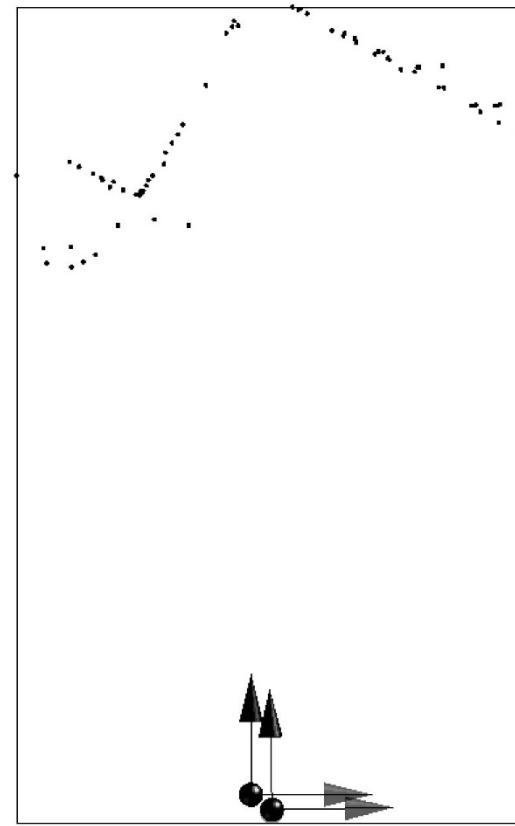
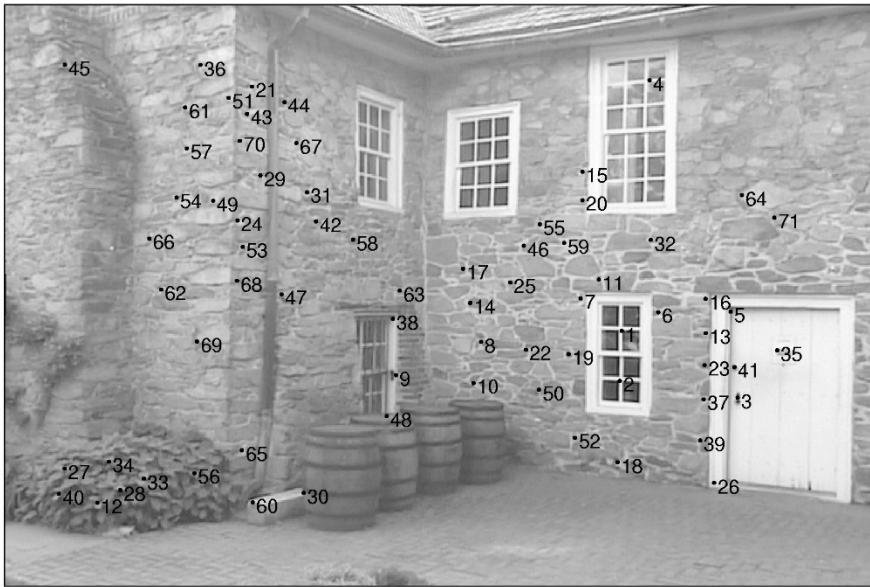
GENERAL STEPS – Feature Selection and Correspondence



1. Small baselines versus large baselines
2. Point features versus line features



GENERAL STEPS – Structure and Motion Recovery

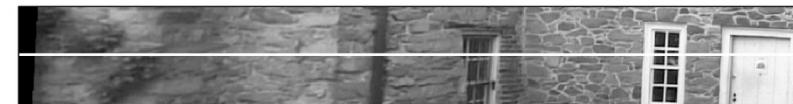
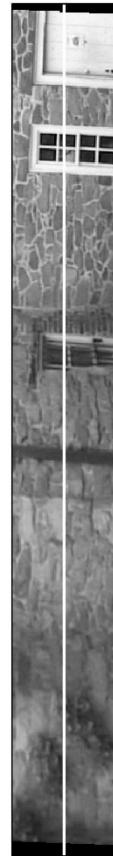


1. Two views versus multiple views
2. Discrete versus continuous motion
3. General versus planar scene
4. Calibrated versus uncalibrated camera
5. One motion versus multiple motions



GENERAL STEPS - Image Stratification and Dense Matching

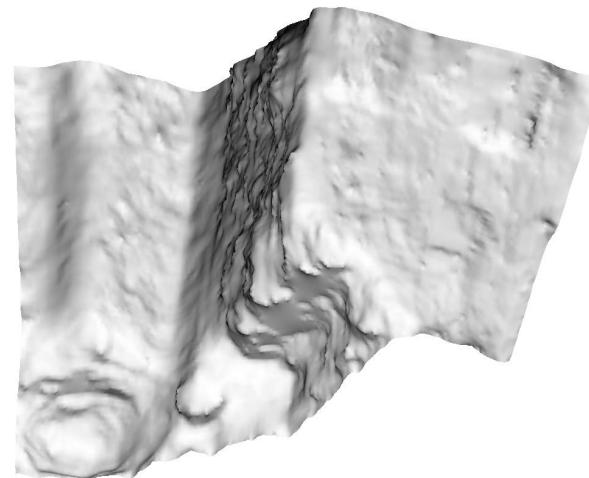
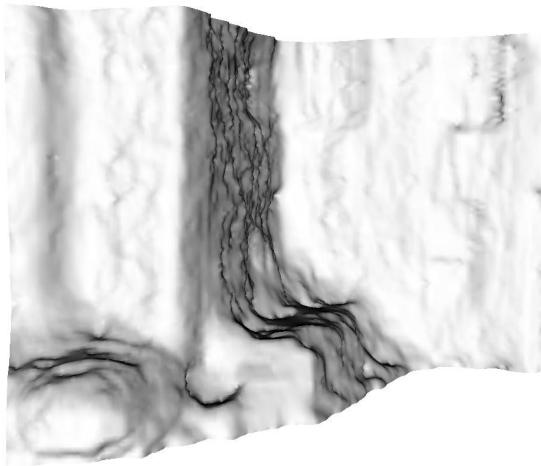
Left



Right



GENERAL STEPS – 3-D Surface Model and Rendering

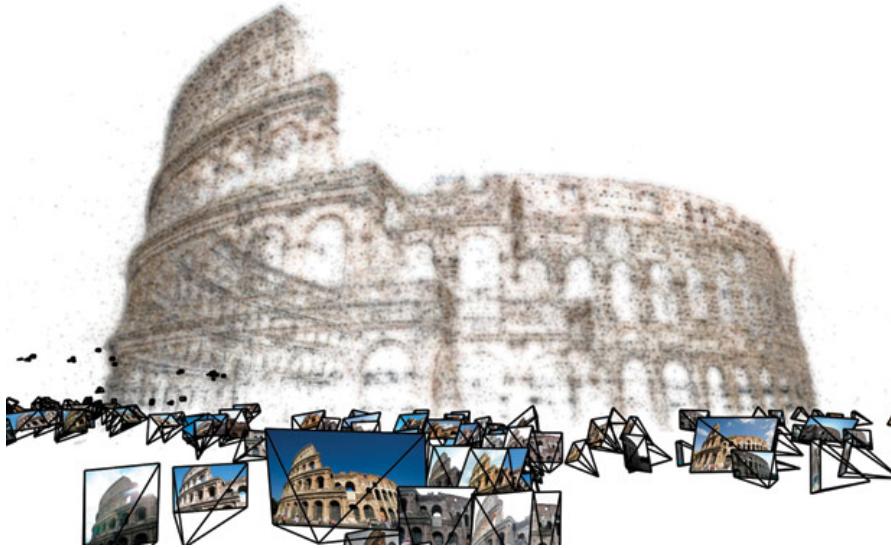


1. Point clouds versus surfaces (level sets)
 2. Random shapes versus regular structures
-



GENERAL STEPS – Image-Based 3D Modeling

Building Rome in One Day



The Colosseum, 2,106 images



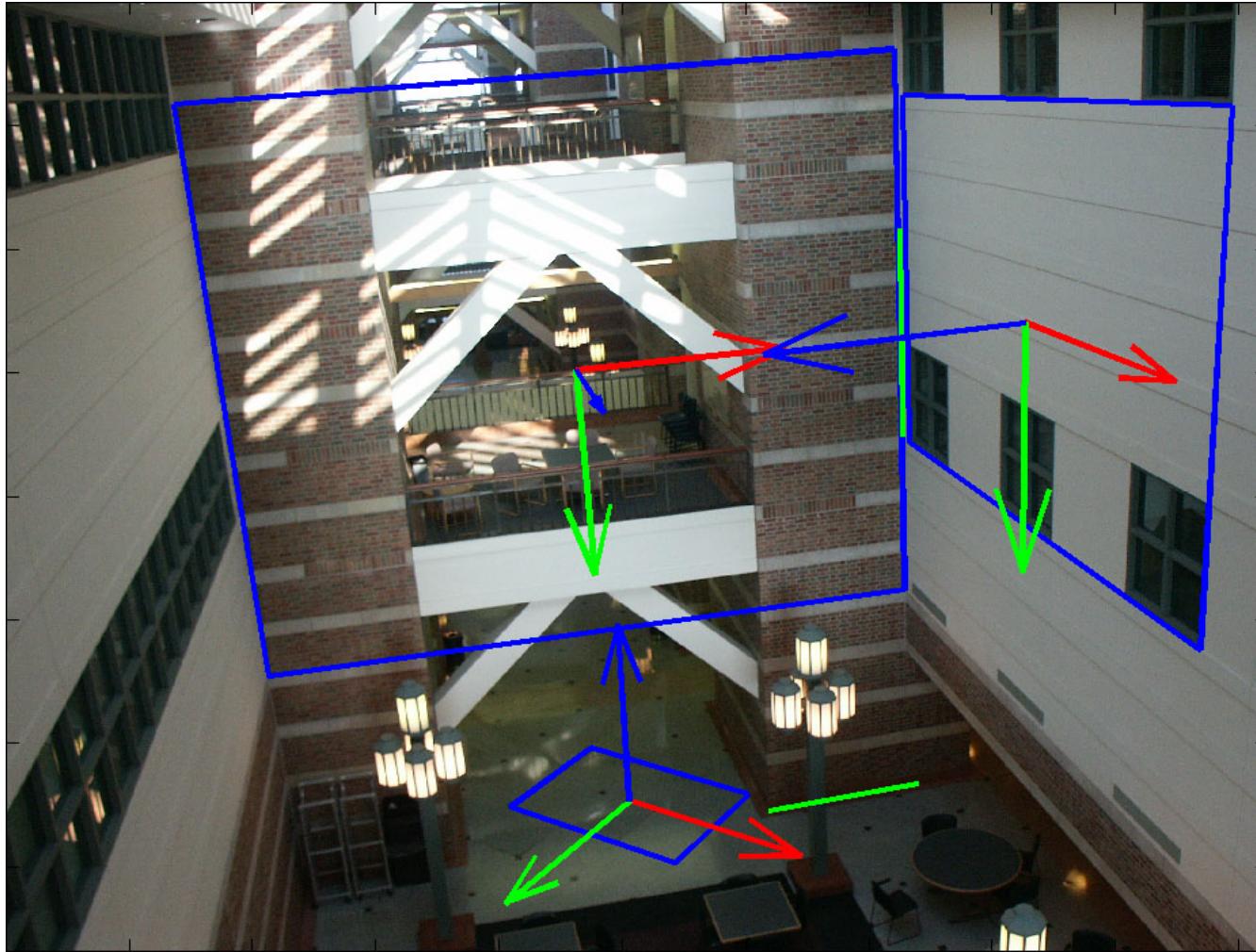


Symmetry based Modeling & Reconstruction





Symmetry based Modeling & Reconstruction



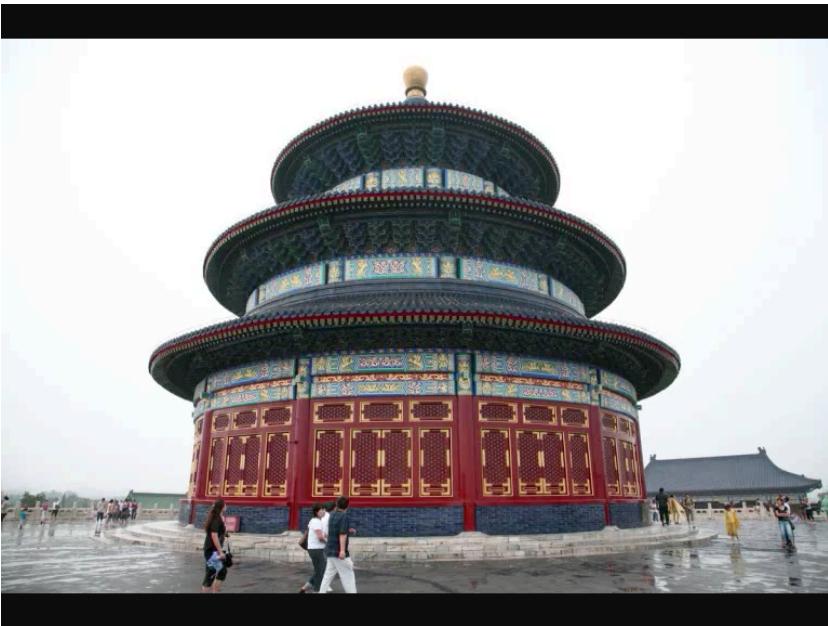


Symmetry based Modeling & Reconstruction





Regular Structure Based Modeling & Reconstruction



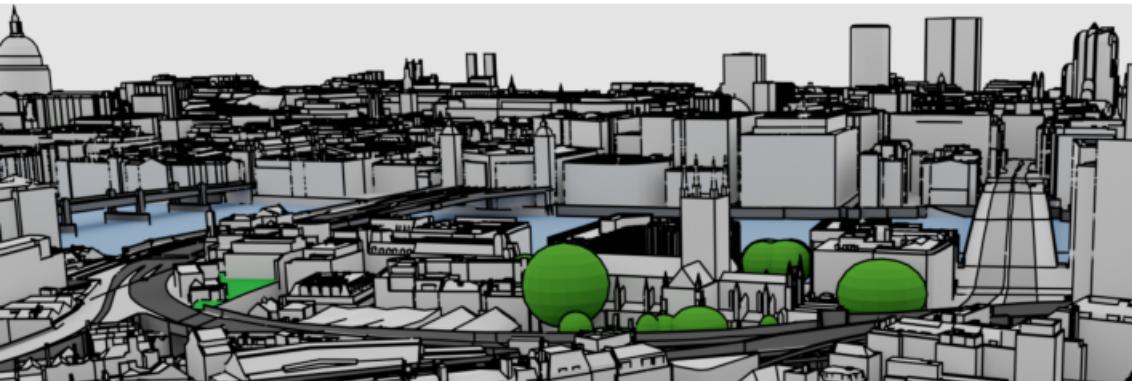
360°





From Images to 3D CAD Models

Holarity: 20 km² of downtown London



(a) Bird's-eye view of the HoliCity CAD model



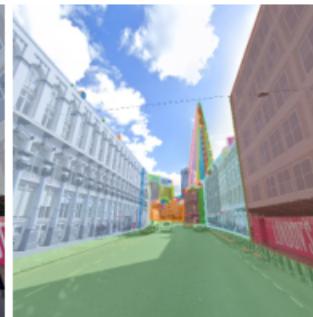
(b) Viewpoint coverage



(c) Panorama



(d) RGB

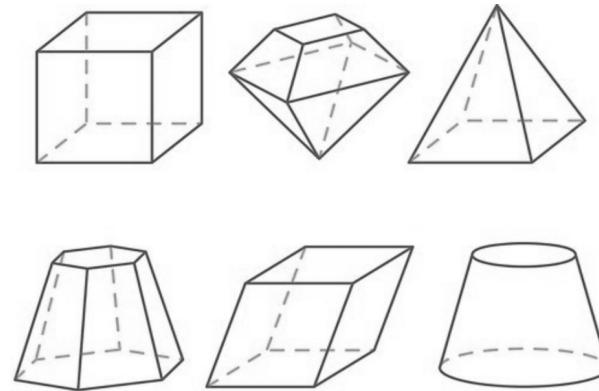
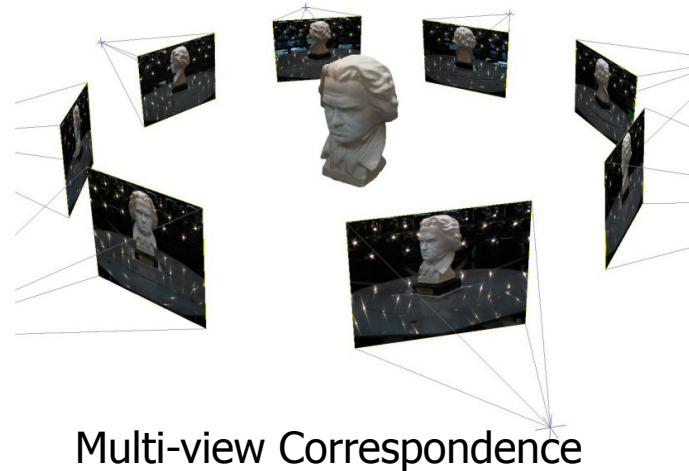


(e) Renderings (surface segments, depth, normal)

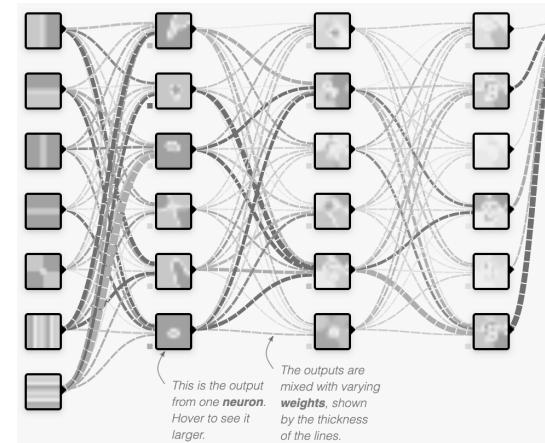


Combine Geometry and Learning (for Structures)

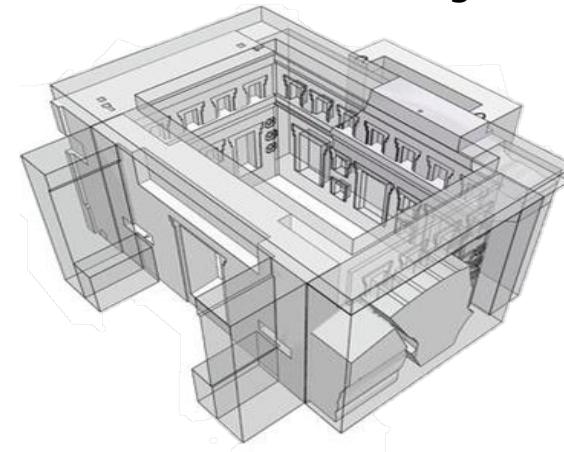
From Images to CAD Model



Geometric Structure



End-to-end Learning



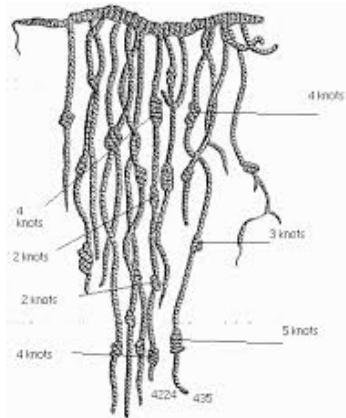
Data Representation



Evolution of Interface and Media

From 1D to 3D, and from physical to virtual...

1D media



Quipu, Inca people
3rd millennium BCE

2D media



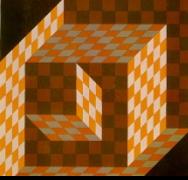
3D media



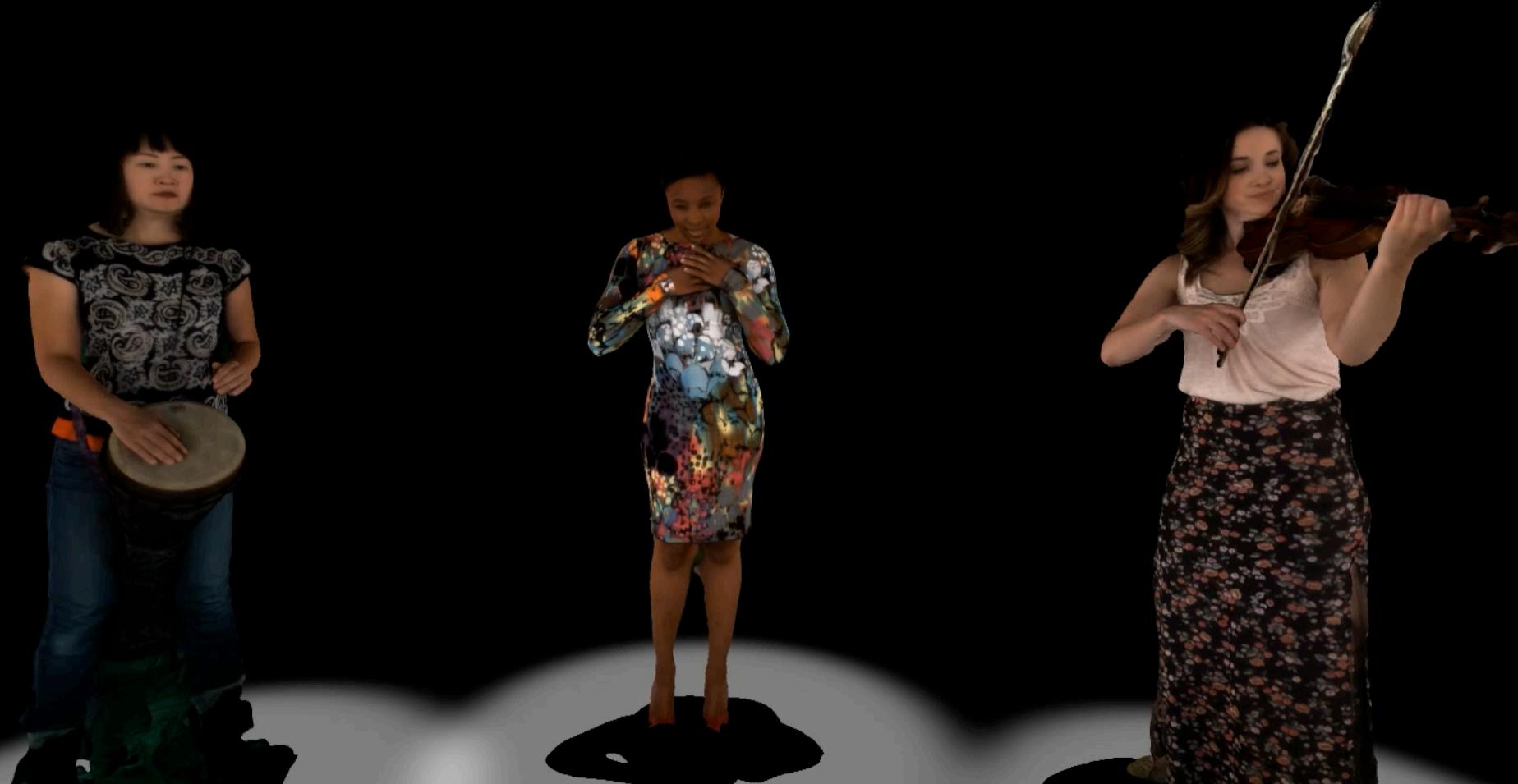


More Applications – Virtual Shopping





More Applications – Virtual Entertainment





Reconstruction from images – The Fundamental Problem

“Rome wasn’t built in a day.”

But a digital Rome may be built in a day!