

3D Photography

Wednesdays 09:30-11:30 – Room 3305

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Office: 1090G, Hunter North (Entrance at 69th bw/ Park and Lexington Avenues)

Class website: http://www.cs.hunter.cuny.edu/~ioannis/3D_f11.html

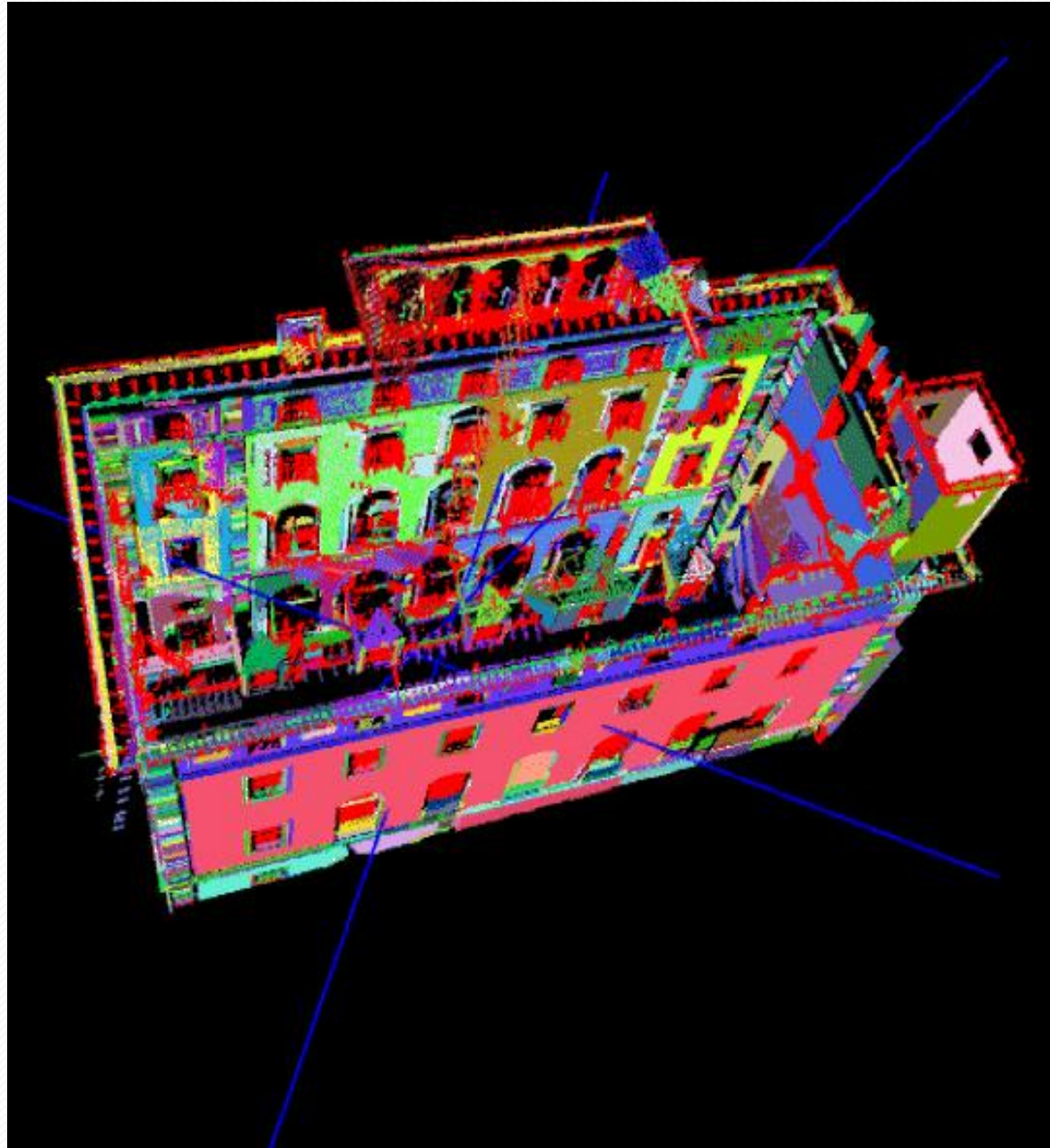
Overview

Create geometric and photometric 3D models

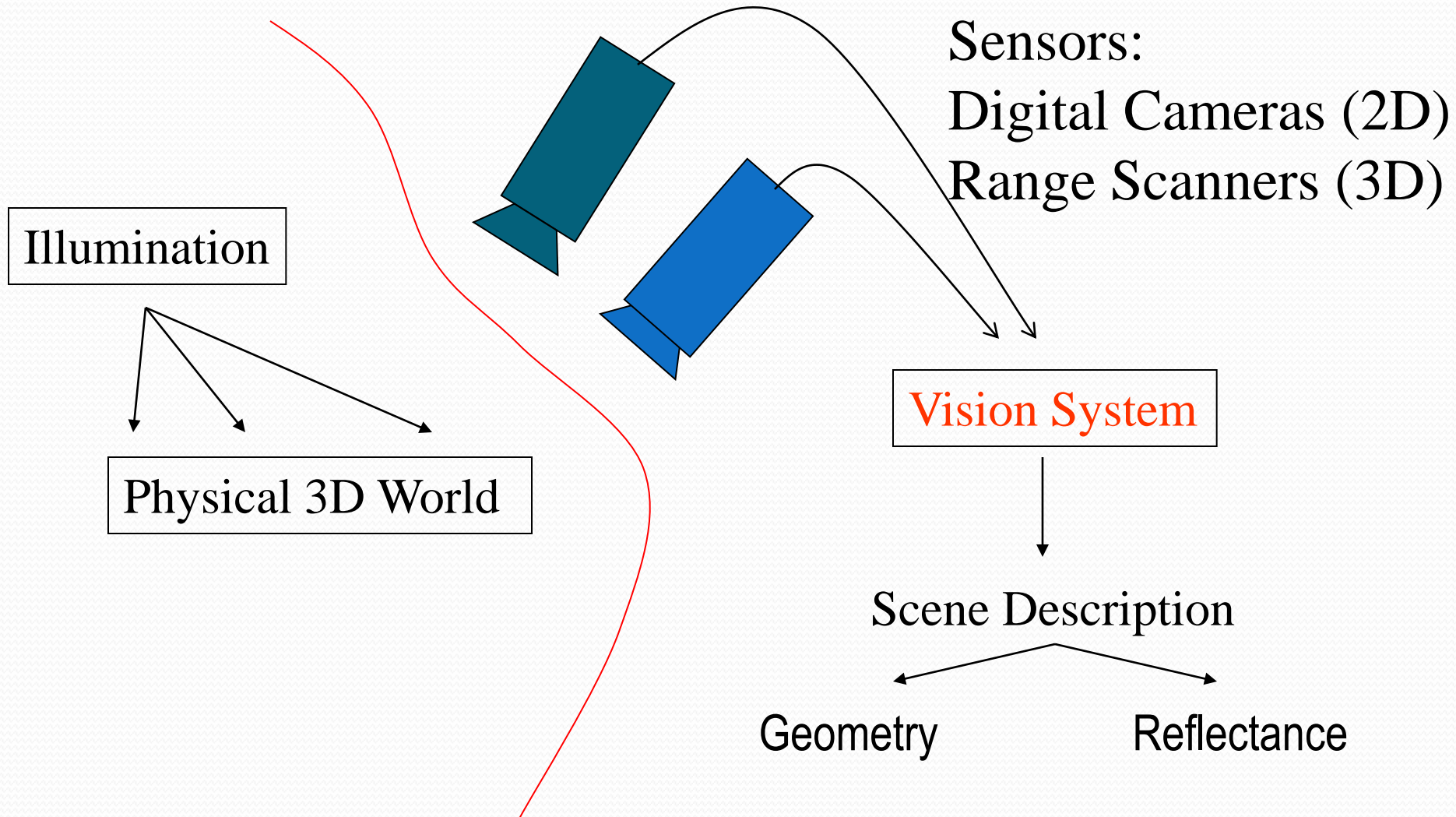
Use Range and Image Sensing

Fusing image data

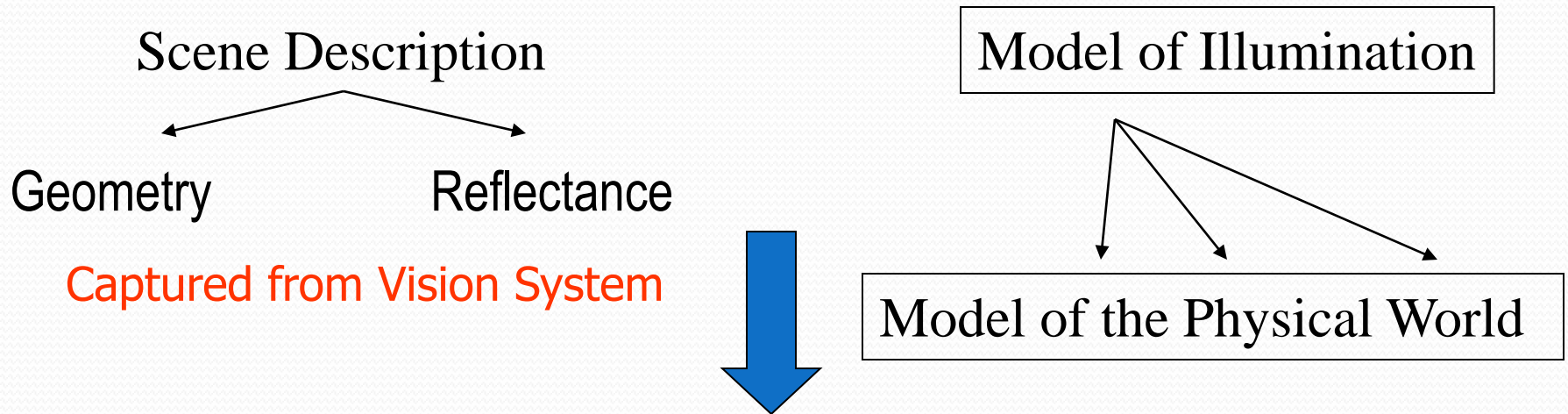
Comprehensive system with automation



Computer Vision



3D Photography & Graphics

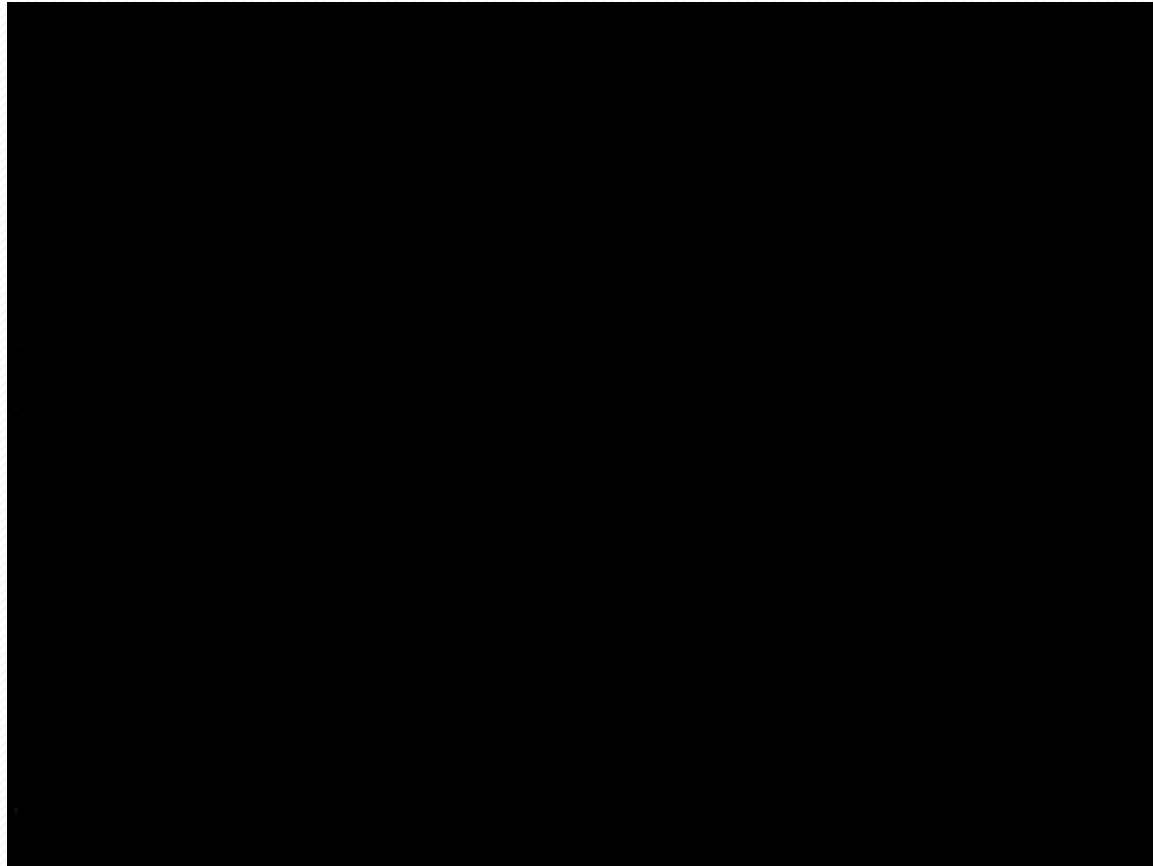


- Modeling [Representation of 3D objects]
- Rendering [Construction of 2D images from 3D models]
- Animation [Simulating changes over time]

Applications

- Virtual environment generation
 - Google Earth
 - acquire model for use in VRML, entertainment, etc
 - Realistic sets: movies and video games
- Reverse engineering
 - acquiring a model from a part copying/modification
- Part inspection
 - compare acquired model to “acceptable” model
- 3D FAX
 - transmit acquired model to remote RP machine
- Architectural site modeling
- Urban Planning
- Historical Preservation and Archaeology
- Reverse Engineering of Buildings

M. Reed – Columbia University [3D Fax]

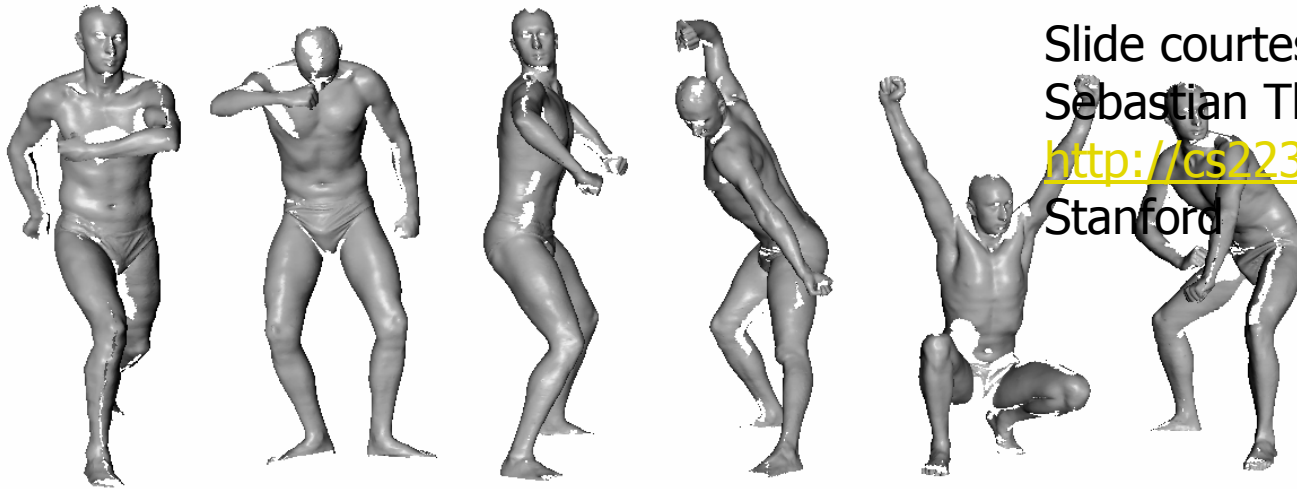


Industrial Inspection

- Determine whether manufactured parts are within tolerances



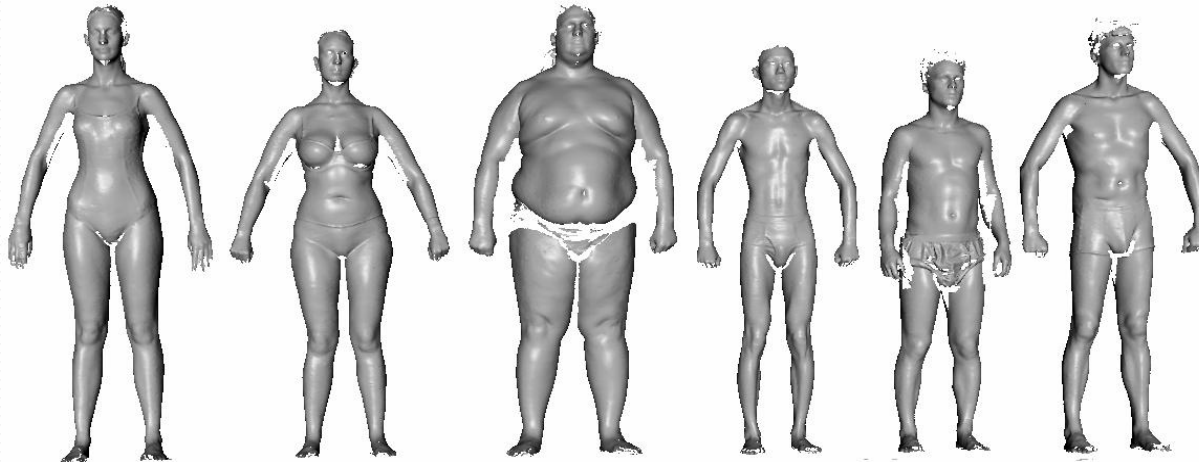
3D Modeling (people)



Slide courtesy of
Sebastian Thrun

<http://cs223b.stanford.edu>

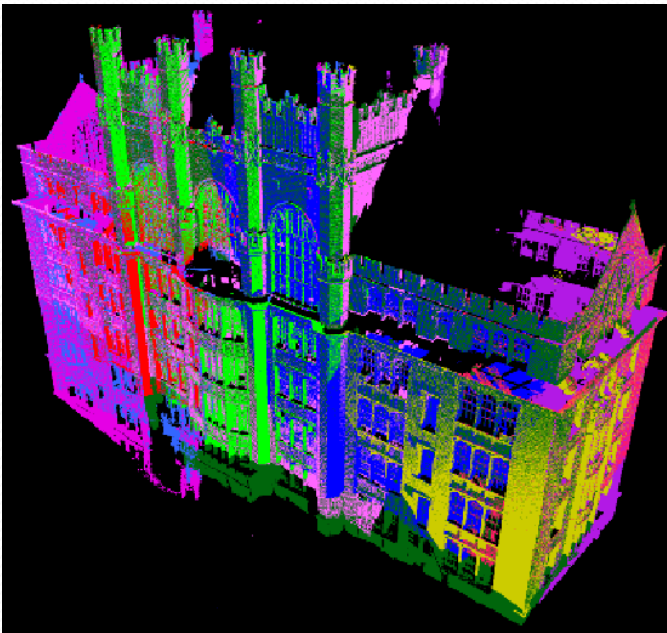
Stanford



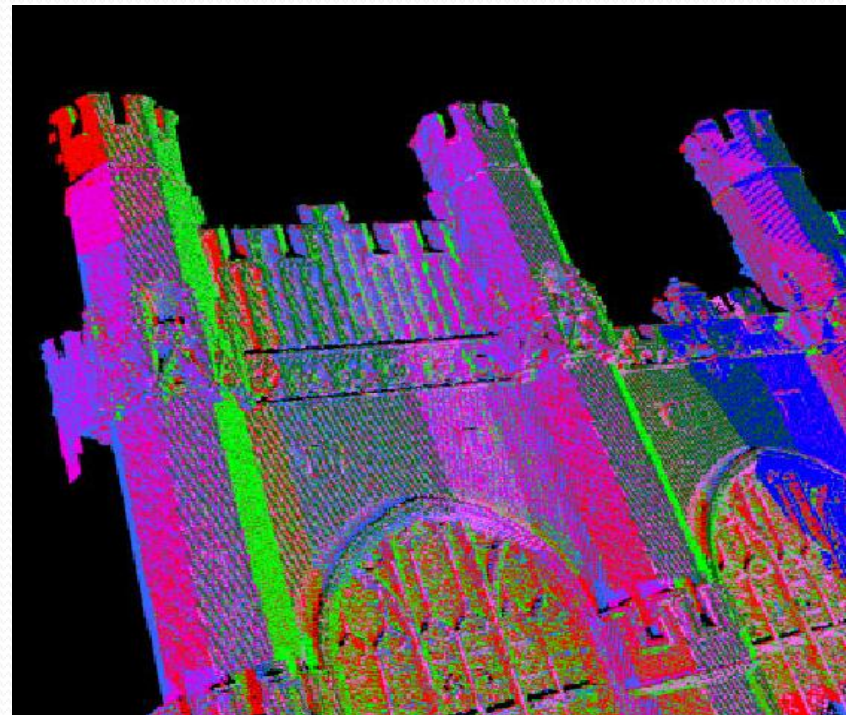
Drago Anguelov

3D PHOTOGRAPHY EXAMPLE

Buildings



Automatic registration.
Each scan has a different color.



Registration details

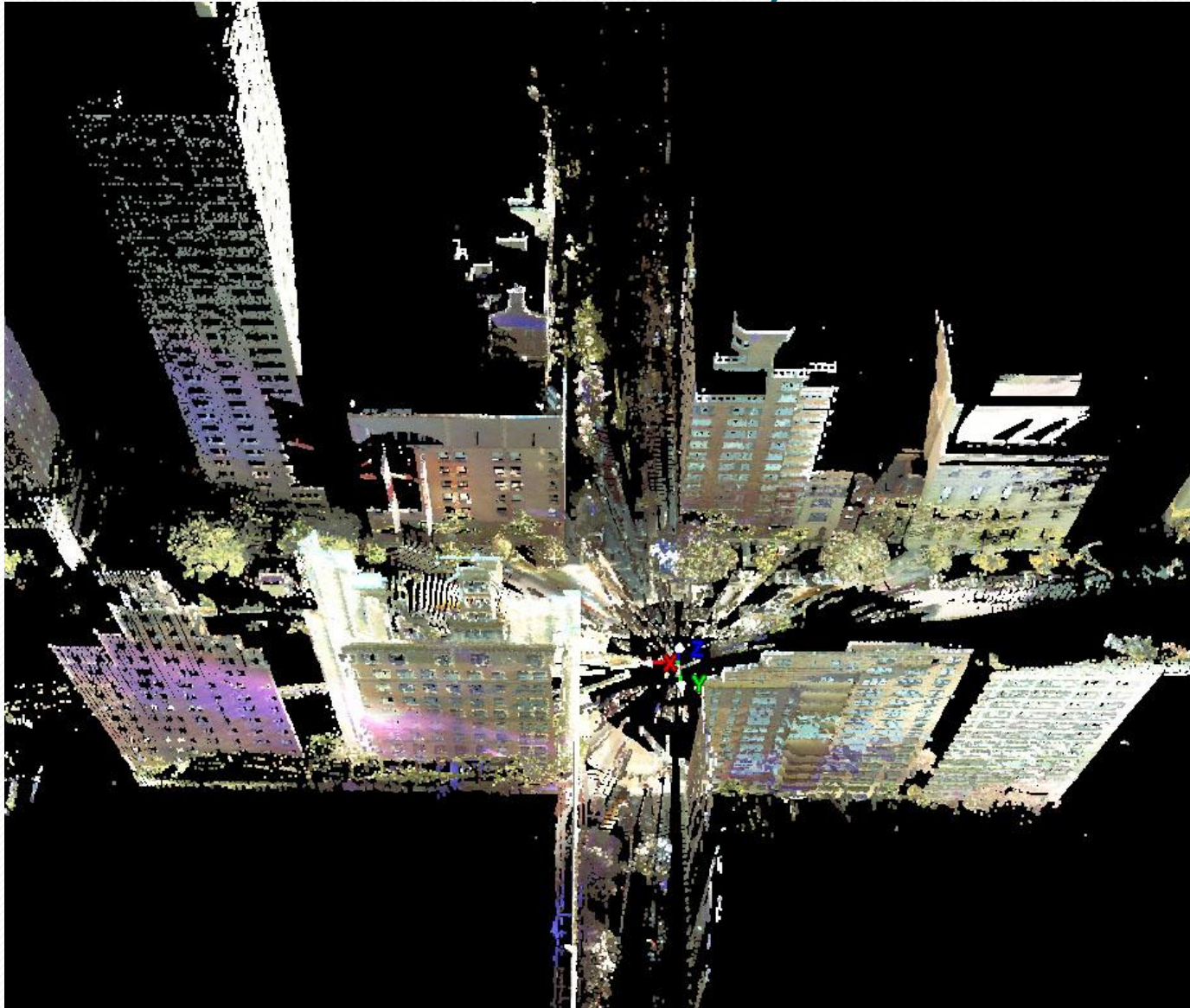


3D PHOTOGRAPHY EXAMPLE

24 scans were acquired of façade of Shepard Hall (City College of NY)



Data Acquisition, Leica Scan Station 2, Park Avenue and 70th Street, NY

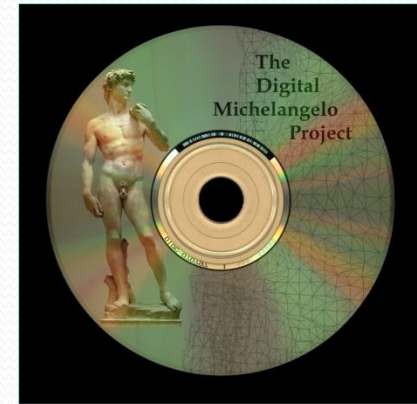


Art

- The Pietà Project
IBM Research



- The Digital Michelangelo Project
Stanford University



- The Great Buddha Project
University of Tokyo



Historical Preservation and Archeology

St. Pierre Cathedral, Beauvais France

World Monuments Fund's Most Endangered List



Photograph

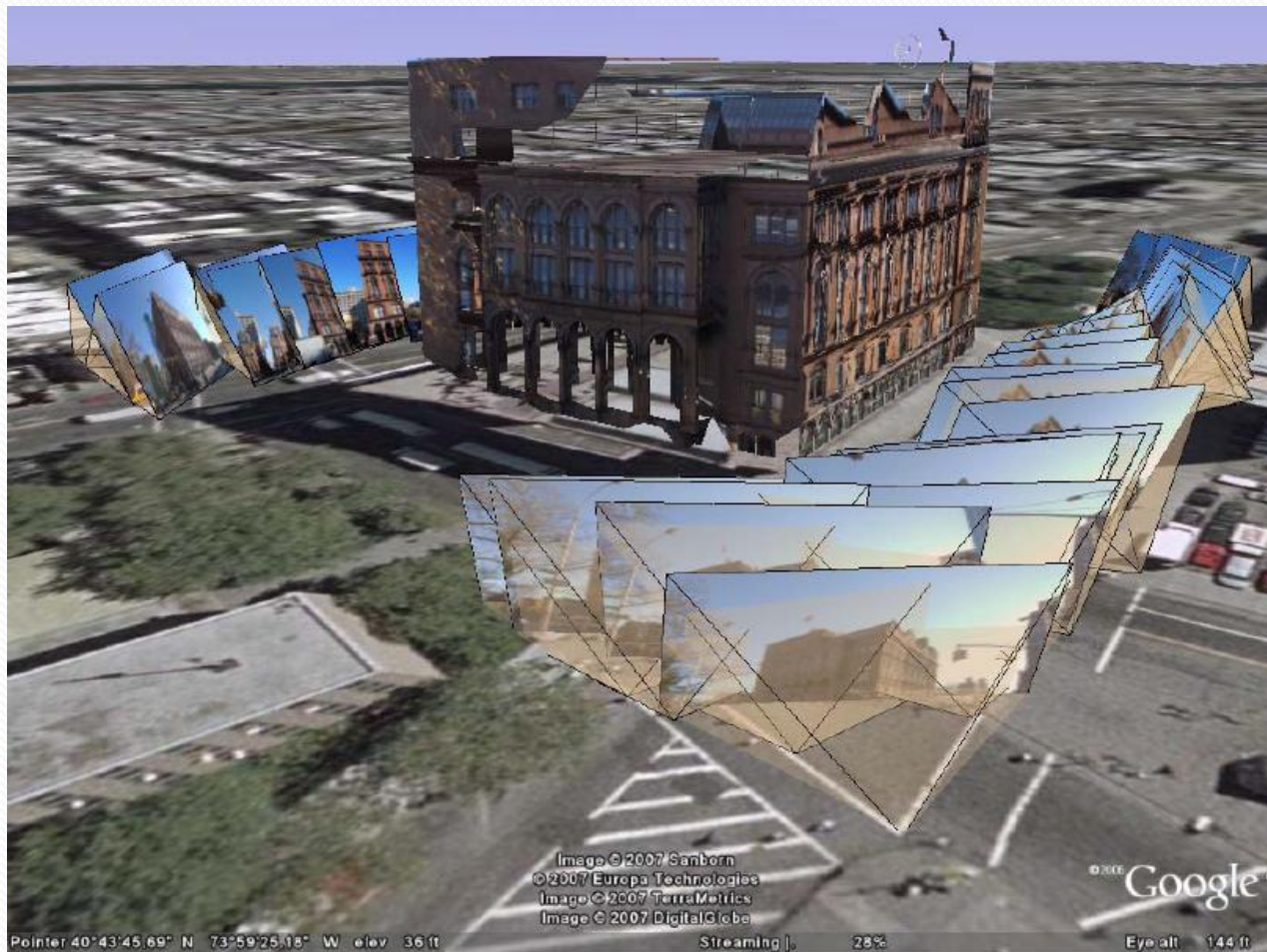
(with P. K. Allen, Columbia University)



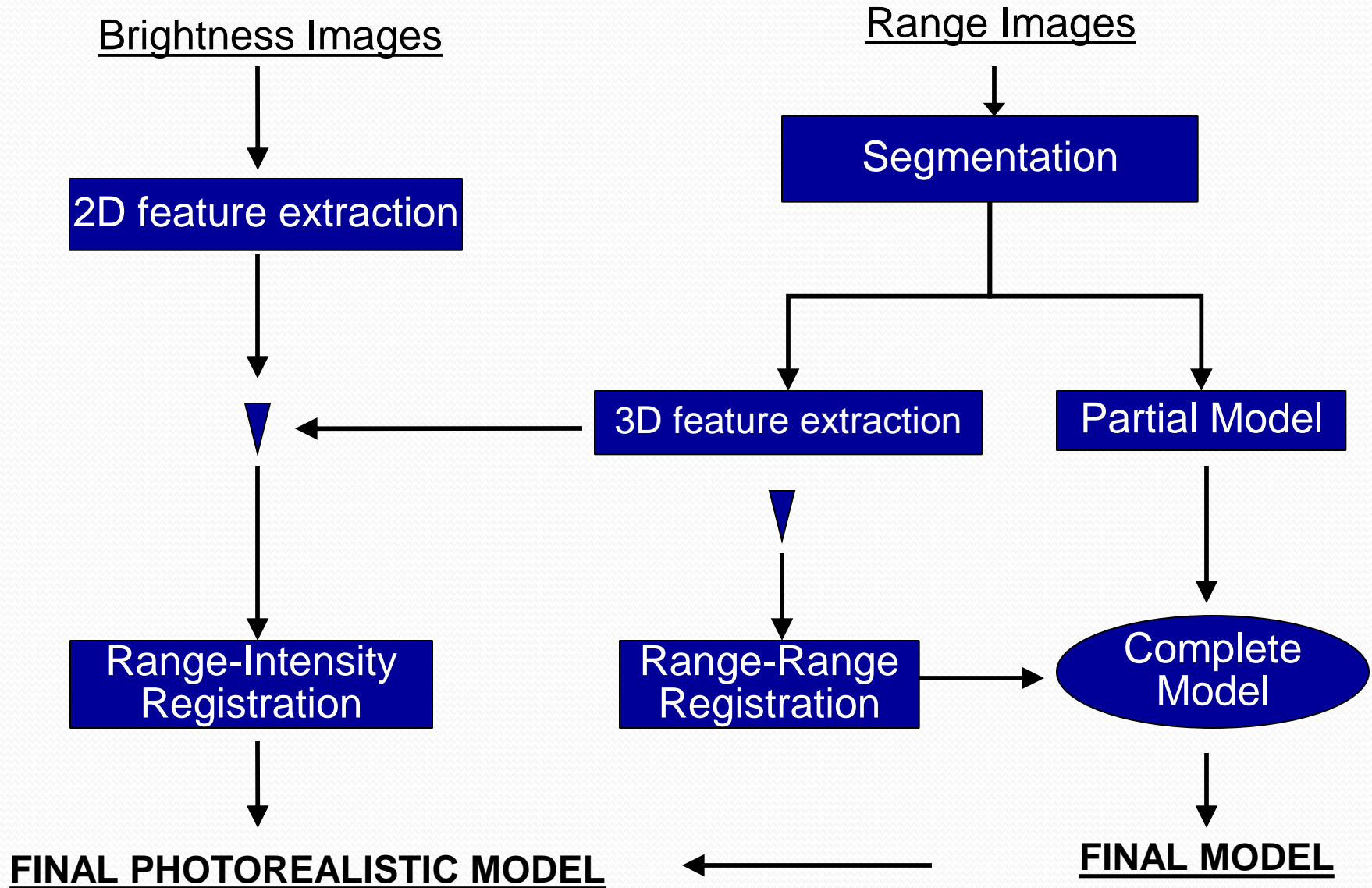
Combined 3D mesh



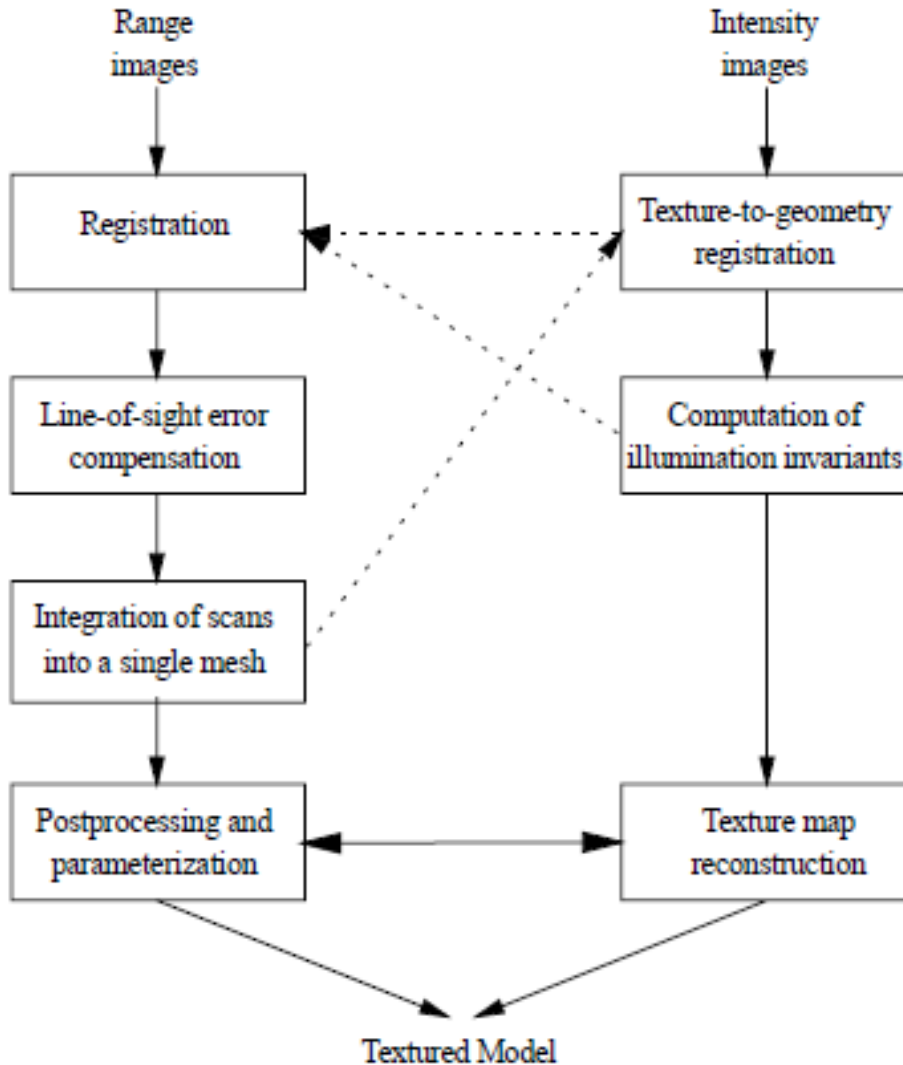
Inserting models in Google Earth



Registration/Modeling Pipeline

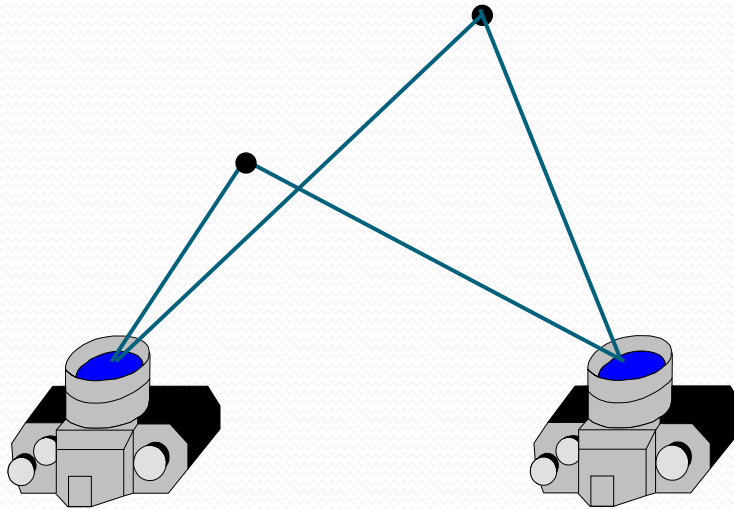


3D Acquisition Pipeline



Main Topics

Data Acquisition and Representation

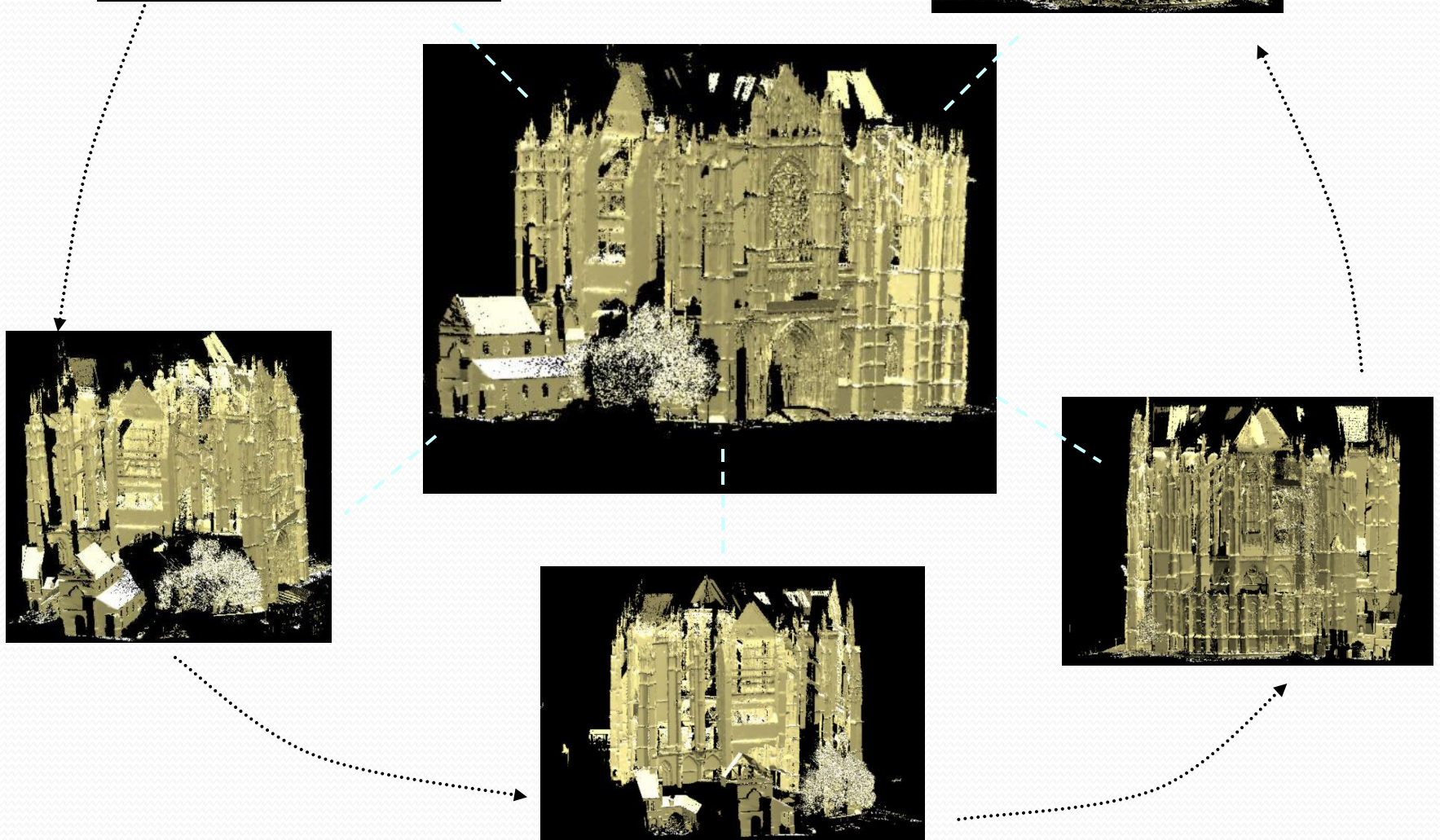
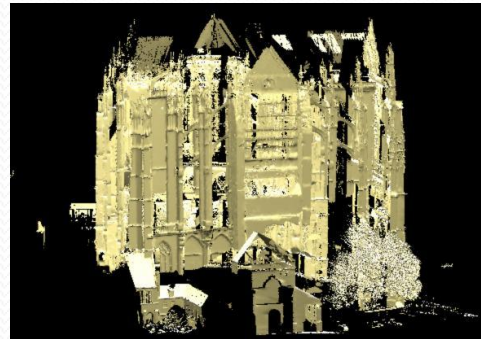
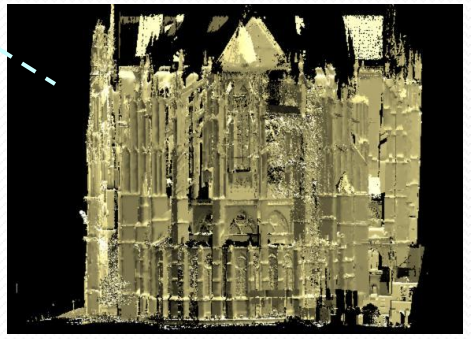
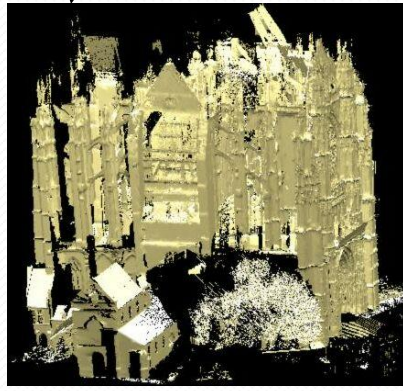
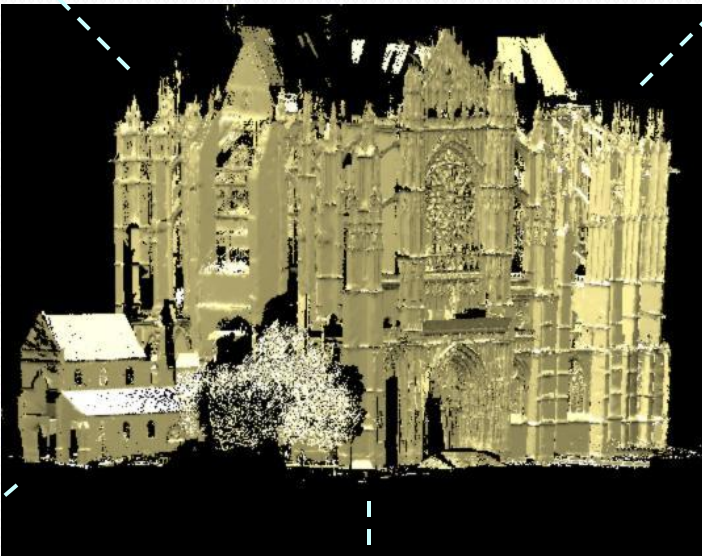
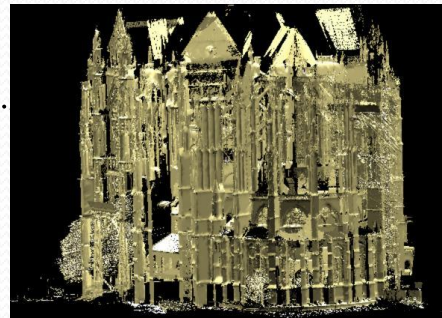
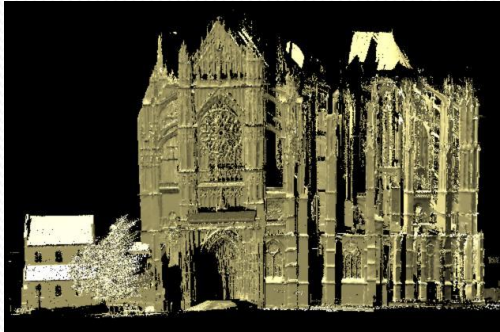


Segmentation



REGISTRATION

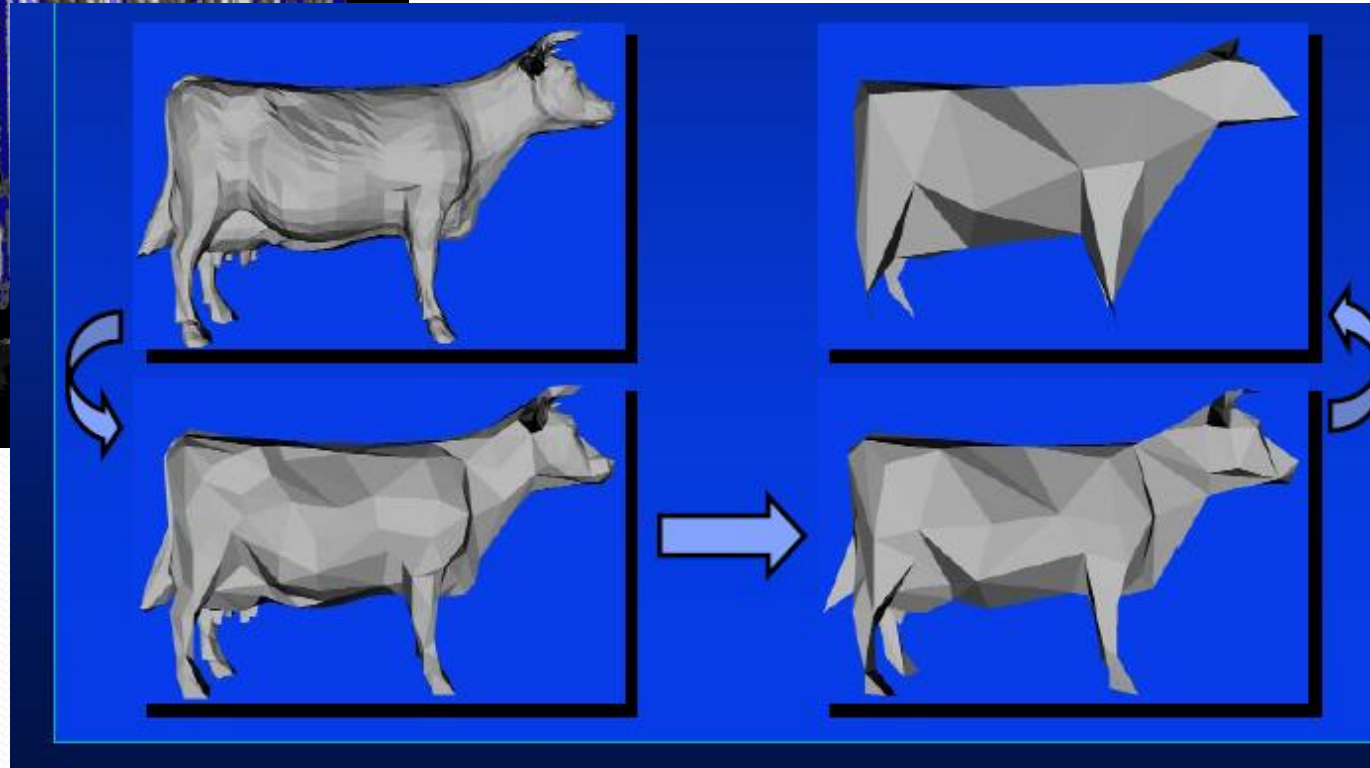
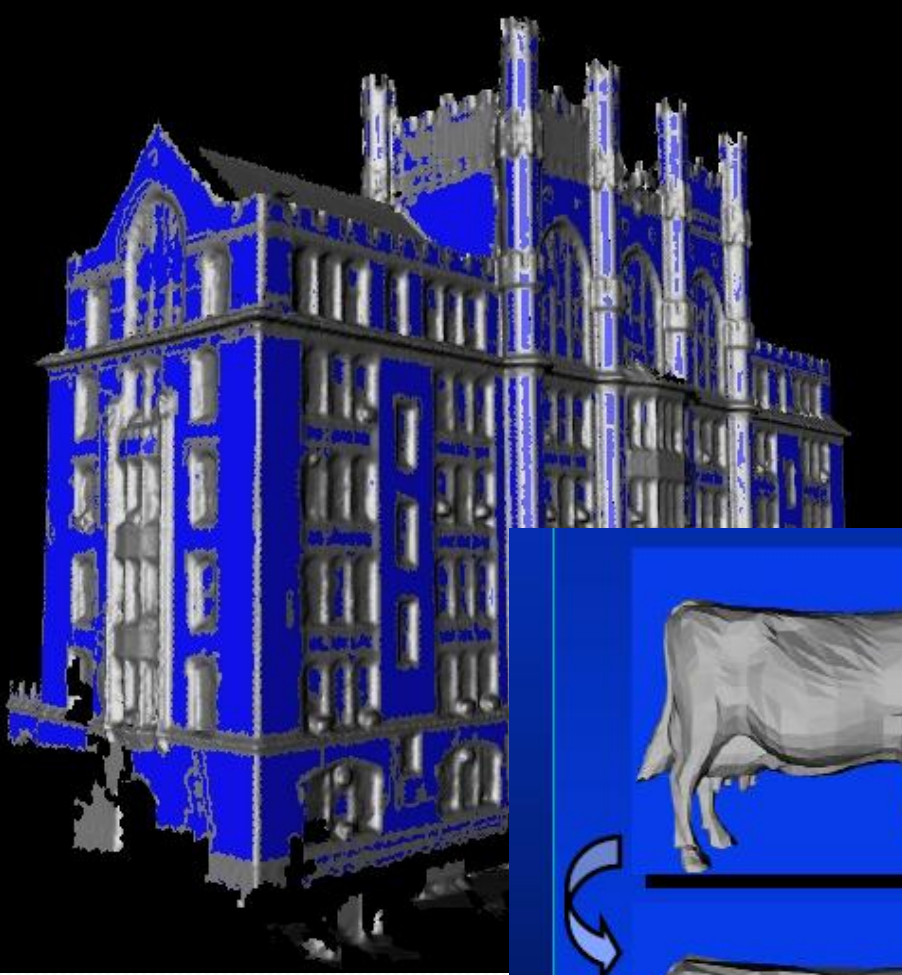
pairwise &
global



3D Modeling (Mesh or volumetric)



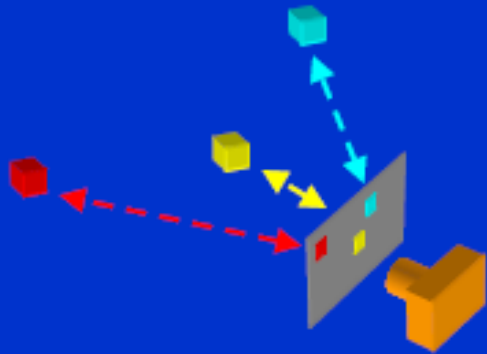
Model simplification



Passive techniques: Stereo and Structure from Motion

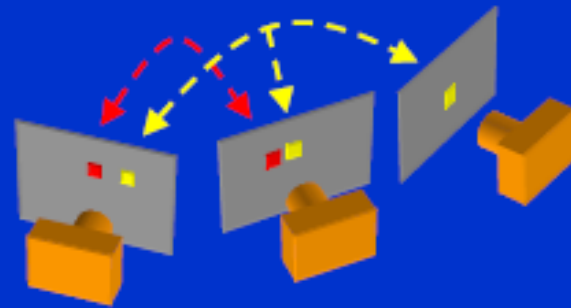
Augmented pin-hole camera model

- Focal point, orientation
- Focal length, aspect ratio, center, lens distortion



**2D \Leftrightarrow 3D
correspondence**

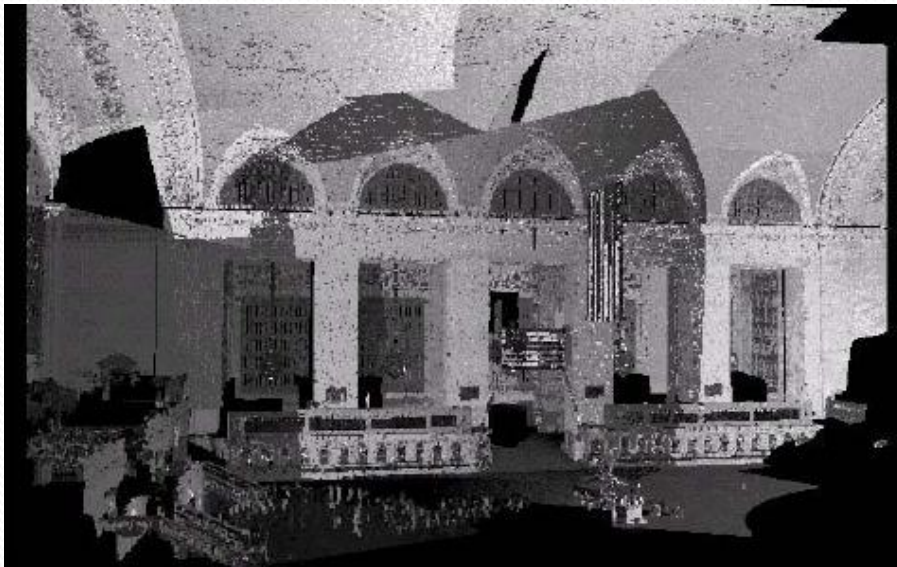
“Classical” calibration



**2D \Leftrightarrow 2D
correspondence**

SFM, “Self-calibration”

3D range to 2D image registration



3D scene

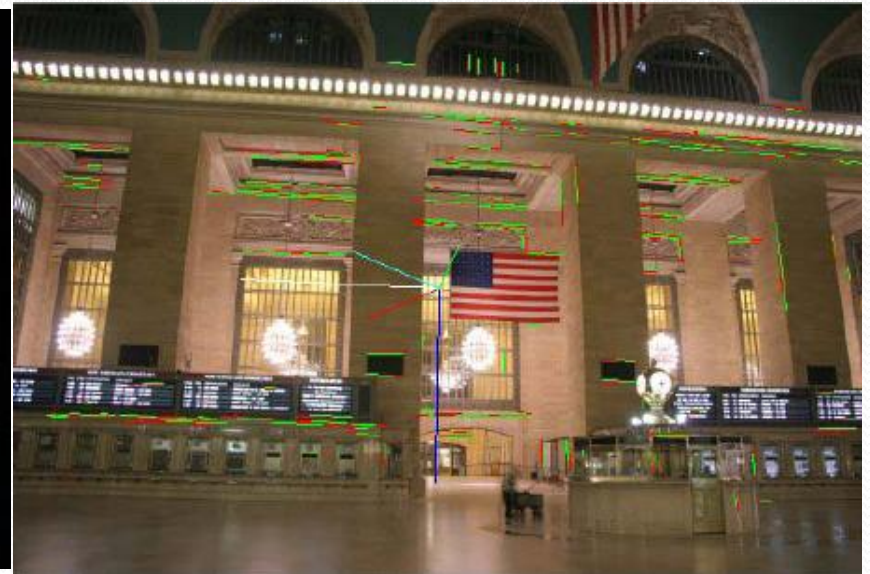


2D image

3D range to 2D image registration



Texture mapped
3D model



Corresponding
2D/proj. 3D lines

TEXTURE MAP ANIMATION



The Façade Modeling System

The screenshot displays the Façade Modeling System interface, which is divided into several functional areas:

- Desk 3:** A menu bar with options: Desktop, Selected, Find, System, and Help.
- Camera Parameters:** A panel for configuring the camera's extrinsic and intrinsic parameters.
 - Extrinsic:** X: -4.41557400, Y: 0.13951700, Z: 3.99351600, RX: 8.61653700, RY: -45.45912300, RZ: -1.07108100.
 - Intrinsic:** u0: 389.40000000, v0: 259.60000000, f: 1132.50000000, a: 1.00000000.
 - Distortion:** cx: 770.5, cy: 506.0, k1: 0.09466, k2: -0.07197.
- Image Viewer - Uni-0002cub.ppm:** Shows a 2D image of a building facade with green wireframe overlays and blue annotations.
- Image Viewer - Uni-0005:** Shows another 2D image of the same building facade with green wireframe overlays and blue annotations.
- Image Info:** A panel displaying image metadata: R: 76, X: 125.01, Y: 21.0, Long: 3689548, Float: 0.0000.
- Camera View:** A 3D perspective view of the building facade model, rendered in green. It includes a 'South' orientation indicator and a camera icon. The status bar at the bottom shows: Uni-0002cub.ppm: (-4.42, 0.14, 3.99), Azim -45.46 Inc 8.62 Roll -1.07.
- Block Form:** A panel for defining and editing blocks.
 - Name:** nwporch
 - Parent:** main
 - Children:** (empty)
 - Parameters:** Name: nwporch_x0, Value: 0.164528.
 - Axis-Aligned:** X: -1.333892, Y: Block MIN Parent MIN, Z: Block MIN Parent MAX, Twirl: (checkbox).
- Image Viewer / World Viewer / Camera Form / Block Form / Stereo Form / Image Info Form:** A vertical stack of tool buttons.
- File List:** A list of image files, with Uni-0005curb.ppm highlighted in yellow.
 - Uni-0002cub.ppm
 - Uni-0005curb.ppm
 - Uni-0008cub.ppm
 - Uni-0009curb.ppm
 - Uni-0011curb.ppm
 - Uni-0012cub.ppm
 - Uni-0014curb.ppm
 - Uni-0015curb.ppm
 - Uni-0016cub.ppm
 - Uni-0017curb.ppm
- Buttons:** Save, Quit, Load..., Save, Save As..., Close.
- FAÇADE:** A large button at the bottom of the interface.

Symmetry Detection

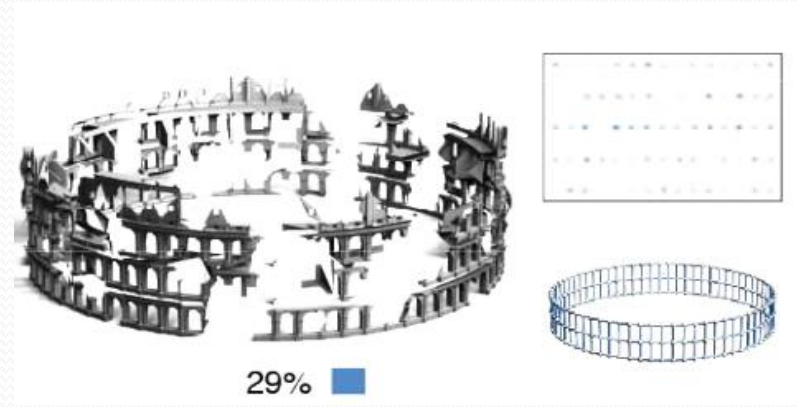
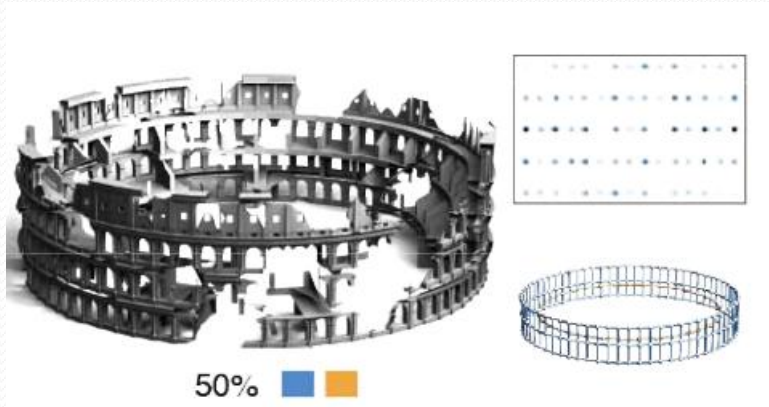
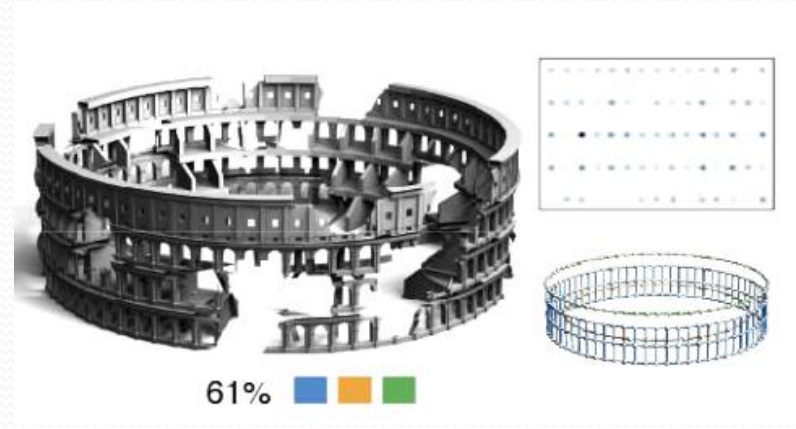
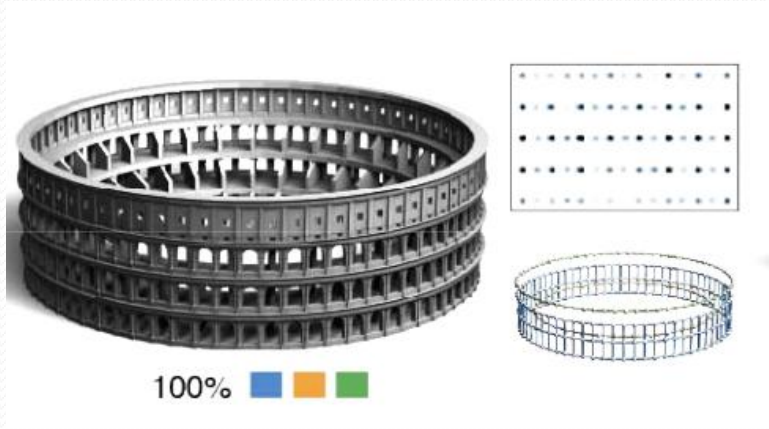
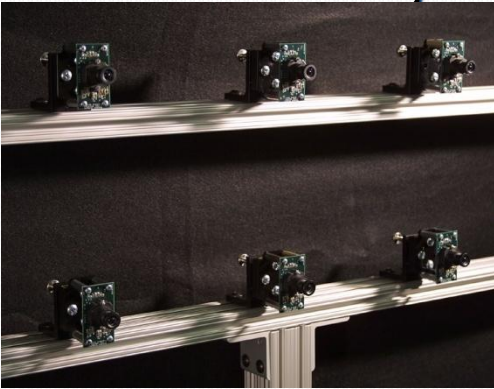


Image-Based Rendering

- Chen and Williams (1993) - view interpolation
- McMillan and Bishop (1995) - plenoptic modeling
- Levoy and Hanrahan (1996) - light field rendering

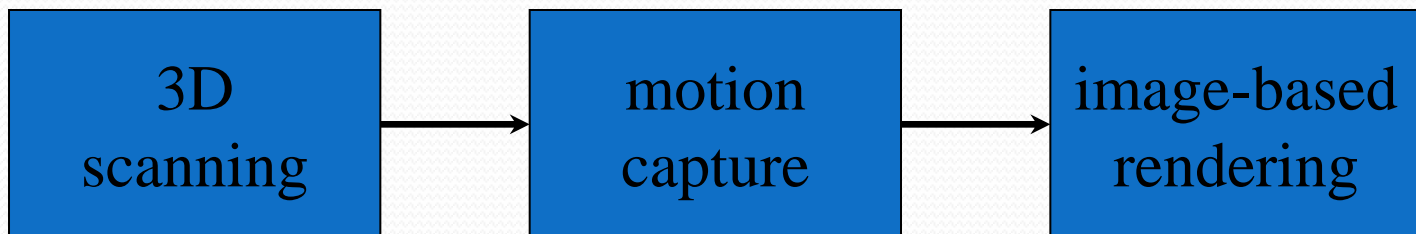


The graphics pipeline

the traditional pipeline



the new pipeline?

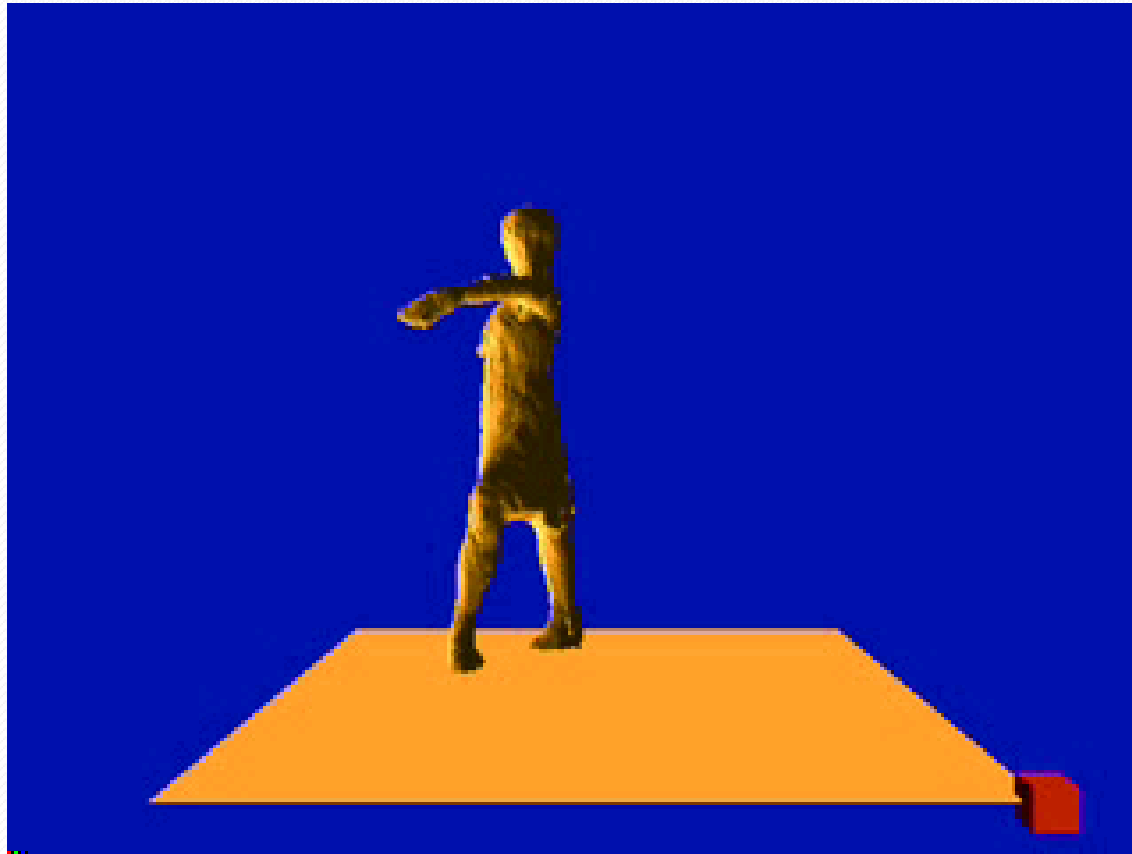


Dynamic Scenes



Image sequence (CMU, Virtualized Reality Project)
http://www.ri.cmu.edu/projects/project_144.html

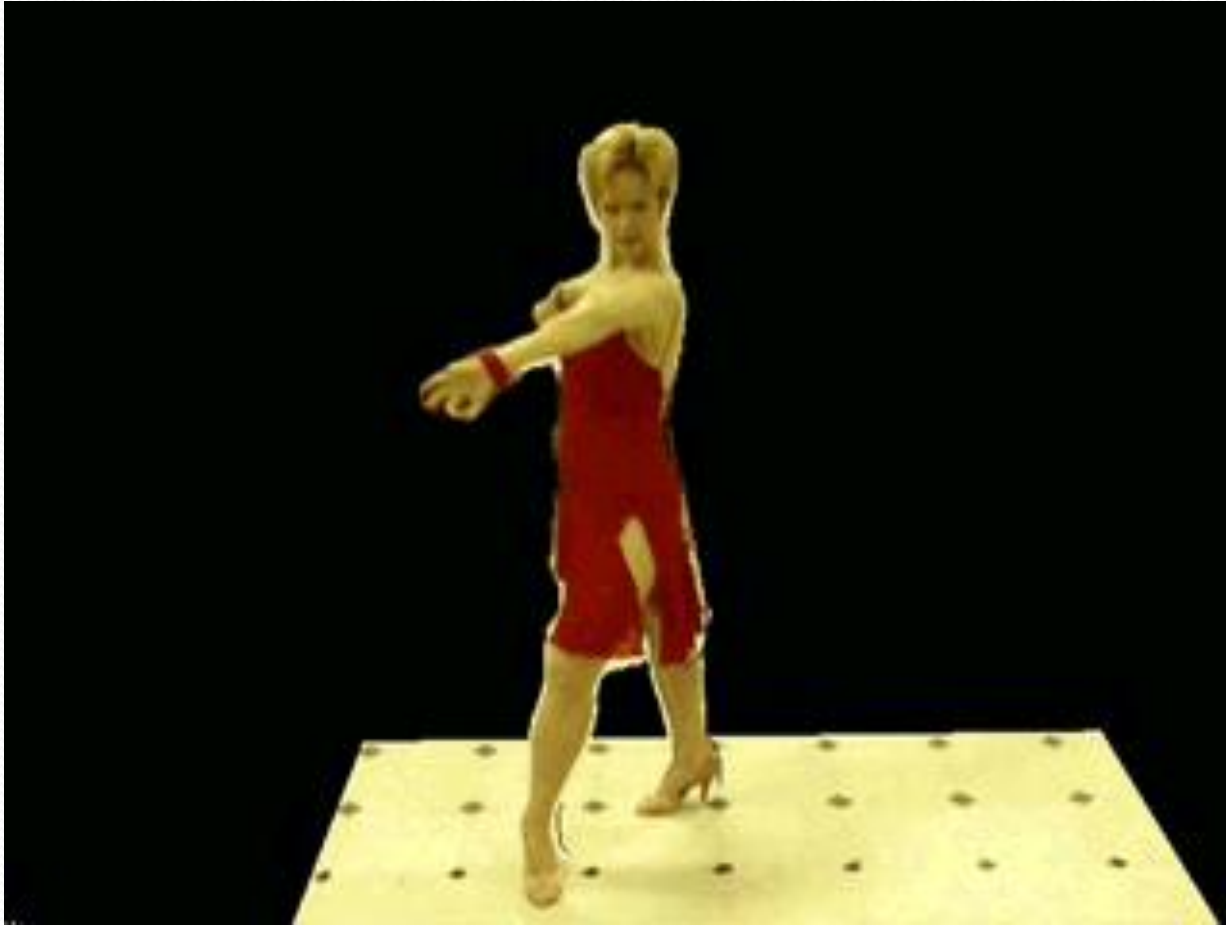
Dynamic Scenes



Dynamic 3D model (CMU, Virtualized Reality Project)

http://www.ri.cmu.edu/projects/project_144.html

Dynamic Scenes



Dynamic texture-mapped model (CMU, Virtualized Reality Project)
http://www.ri.cmu.edu/projects/project_144.html

Libraries

- Open Inventor Graphics Libraries
- Coin3D implements Open Inventor API:
<http://www.coin3d.org/>
- Online book:
http://www-evasion.imag.fr/Membres/Francois.Faure/doc/inventorMentor/sgi_html/
- **Book:** The Inventor Mentor : Programming Object-Oriented 3D Graphics with Open Inventor, Release 2