Graphics research and courses at Stanford

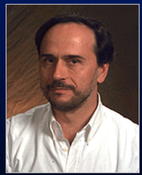
http://graphics.stanford.edu

Graphics faculty

Pat Hanrahan
rendering, architectures, visualization

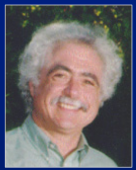
Marc Levoy
photography, imaging, rendering

Ron Fedkiw
simulation, natural phenomena



Leo Guibas
modeling, geometry

Related areas



Terry Winograd
human-computer interaction

Mark Horowitz
VLSI, hardware

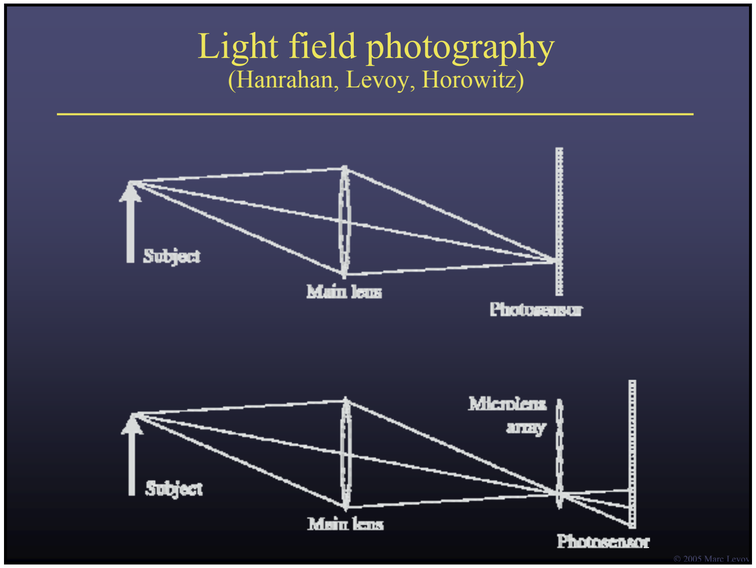
Scott Klemmer
human-computer interaction

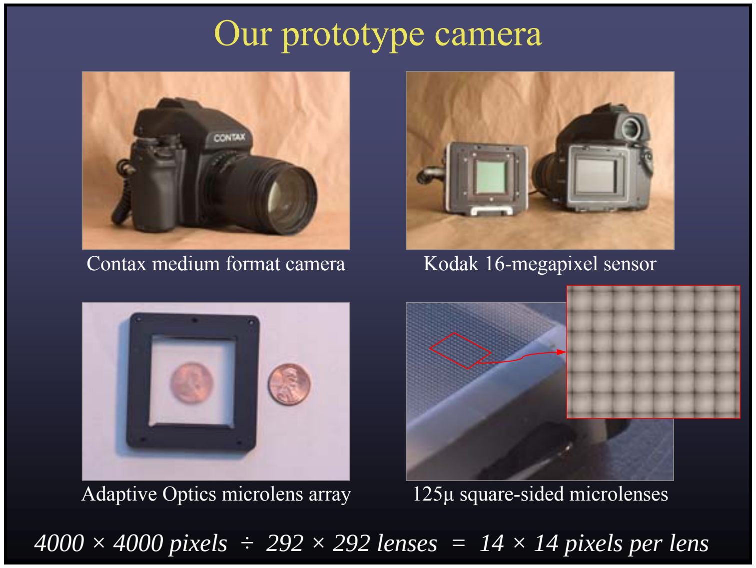
Sebastian Thrun
robotics, computer vision

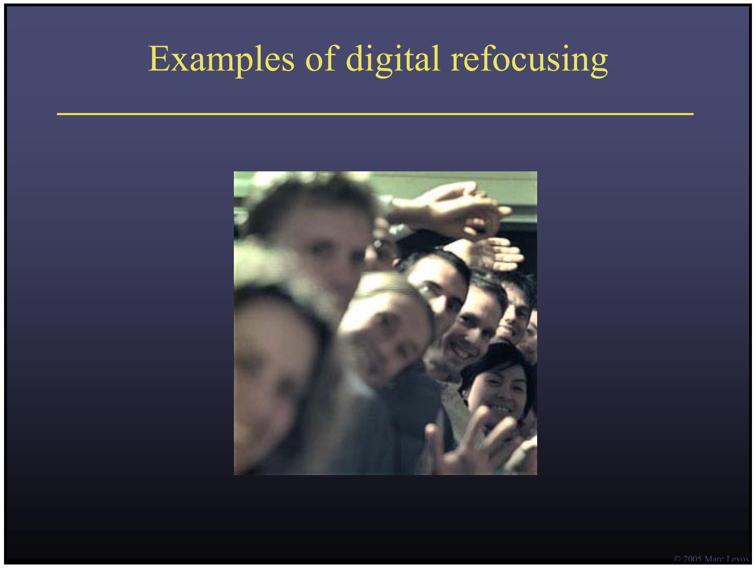
Research projects

- Digital Michelangelo project
- Solving the Forma Urbis Romae
- Visualizing cuneiform tablets
- Modeling subsurface scattering
- Kinetic data structures
- Measuring and modeling reflectance
- Acquisition and display of light fields
- Image-based modeling and rendering
- Geometry for structural biology
- Reflective integral digital photography
- Parallel graphics architectures
- Stanford multi-camera array
- Non-photorealistic visualization
- Multi-perspective panoramas
- Automatic illustration systems
- Physics-based modeling and simulation
- Virtual humanoid
- Real-time programmable shading

…and many more


Light field photography
(Hanrahan, Levoy, Horowitz)
Subject
Main lens
Photosensor
Microlens
array
Subject
Main lens
Photosensor


Our prototype camera
CONTAX
Contax medium format camera
Kodak 16-megapixel sensor
Adaptive Optics microlens array
125μ square-sided microlenses
4000 × 4000 pixels ÷ 292 × 292 lenses = 14 × 14 pixels per lens


Examples of digital refocusing

Refocusing portraits

Misfocused camera

Refocusing portraits

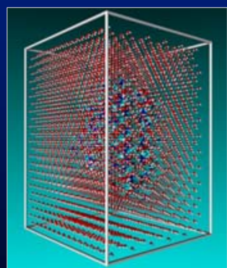
Action photography

Focusing through a splash of water

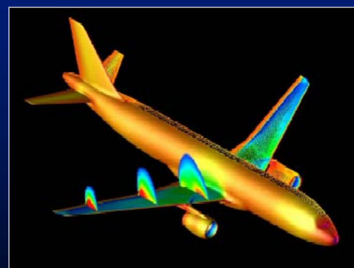
Scientific computing on GPUs
(Hanrahan)

- 3GHz Pentium P4 SSE
  - *–6 GFLOPs*
- ATI X800XT (R420) fragment processor:
  - *520 Mhz * 16 pipes * 4 wide * 1 flop/inst * 1 inst/cycle = 66.5 GFLOPs*
- key challenge: how to program GPUs?

Stream programming on GPUs



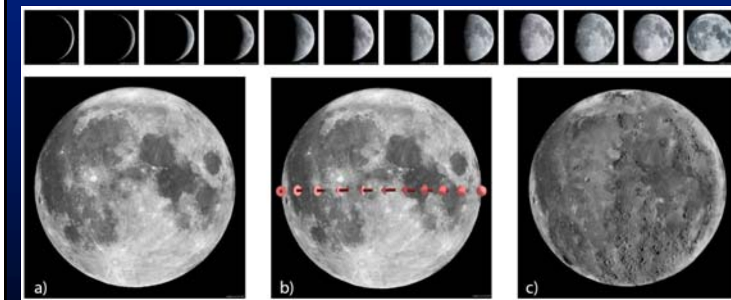
molecular dynamics
folding@home



fluid flow

Non-photorealistic rendering for scientific illustration

(Hanrahan)



- for each phase of moon, extract strip at illumination horizon
- mosaic together so that light appears raking everywhere

Stanford multi-camera array

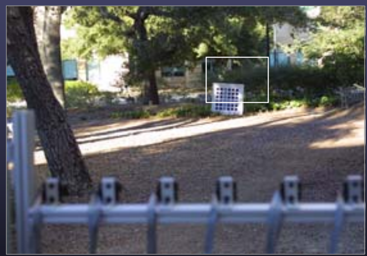
(Levoy, Horowitz)

- 640 × 480 pixels × 30 fps × 128 cameras
- synchronized timing
- continuous streaming
- flexible arrangement

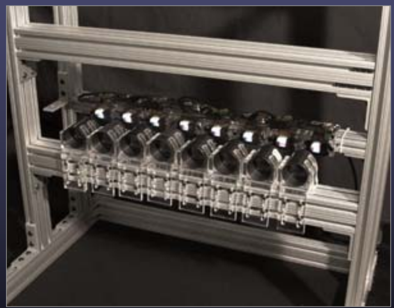
Ways to use large camera arrays

- widely spaced → light field capture
- tightly packed → high-performance imaging
- intermediate spacing → synthetic aperture photography

Example of synthetic aperture photography



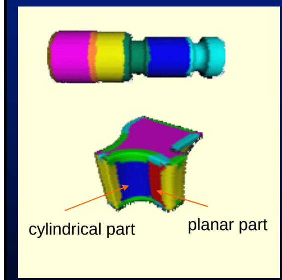
Arrays of cameras and projectors



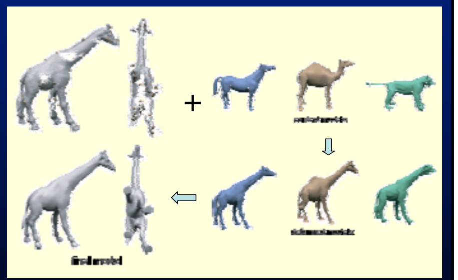
- real-time 3D capture of moving scenes
- non-photorealistic illumination

Algorithms for point clouds

(Guibas)



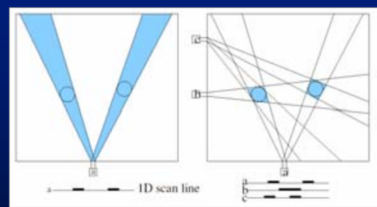
3D shape segmentation

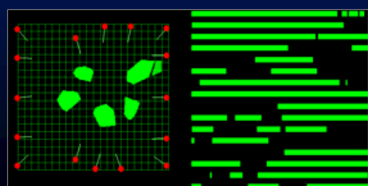


completion using prior models

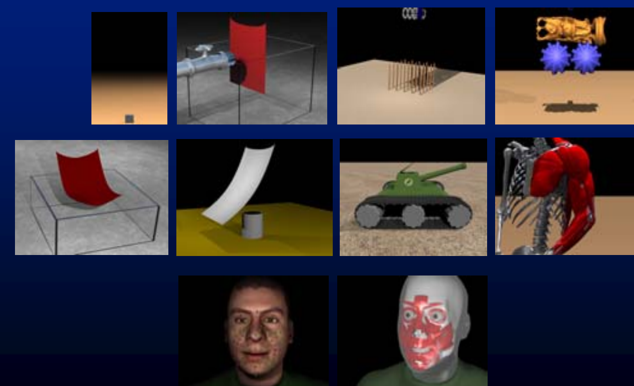
Geometric reasoning for networks of cameras
(Guibas)

- estimate spatial occupancy by sharing occlusion maps across multiple cameras





Physics-based modeling and simulation
(Fedkiw)



The Stanford CityBlock Project
(Thrun, Levoy)

- goal
  - to obtain a useful visual representation of commercial city blocks
- applications
  - graphical yellow-pages – associate images with web sites
  - in-car navigation – get a picture of the place you're going

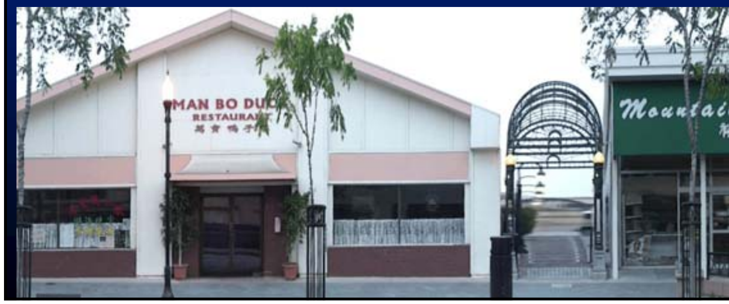
The vehicle

- Sebastian Thrun's modified Volkswagen Toureg
- GPS + IMU + odometry + LIDAR + high-speed video

Multiperpective panoramas

- capture video while driving
- extract middle column from each frame
- stack them to create a panorama

Multiperpective panoramas



Multiperpective panoramas

Courses
(http://graphics.stanford.edu/courses/)

- CS 205 – Mathematics for Robotics, Vision, and Graphics Fedkiw
- CS 248 – Introduction to Computer Graphics Levoy
- CS 223B – Introduction to Computer Vision Thrun

- CS 348A – Geometric Modeling Guibas
- CS 348B – Image Synthesis Techniques (rendering) Hanrahan
- CS 368 – Geometric Algorithms (computational geometry) Guibas

- CS 448 – Topics in Computer Graphics everybody
- CS 468 – Topics in Geometric Algorithms Guibas

Examples of topics

- CS 448 - Topics in Computer Graphics
  - data visualization
  - modeling virtual humans
  - computational photography
  - real-time graphics architectures
- CS 468 - Topics in Geometric Algorithms
  - introduction to computational topology
  - matching techniques and similarity measures

"Retreats"

http://graphics.stanford.edu

Stanford Computer Graphics Laboratory