

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



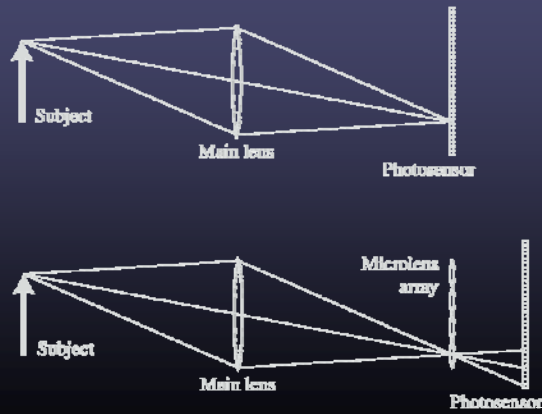
Sebastian Thrun
robotics, computer vision

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)



Our prototype camera



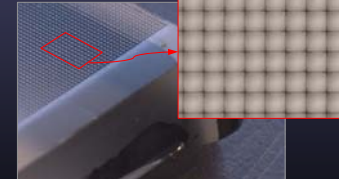
Contax medium format camera



Kodak 16-megapixel sensor



Adaptive Optics microlens array



125µ square-sided microlenses

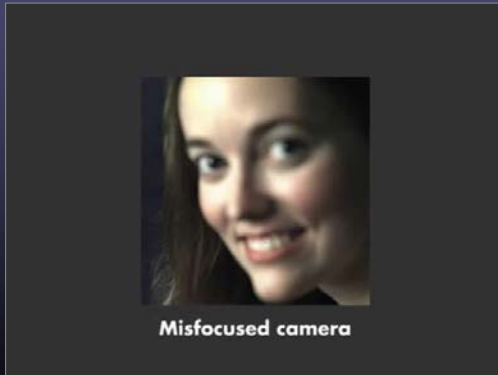
$$4000 \times 4000 \text{ pixels} \div 292 \times 292 \text{ lenses} = 14 \times 14 \text{ pixels per lens}$$



Examples of digital refocusing

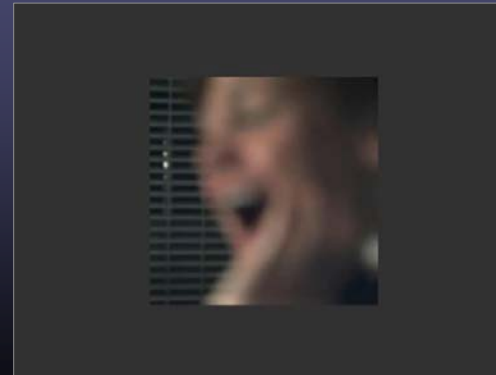


Refocusing portraits



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Refocusing portraits



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Action photography



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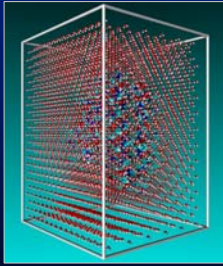
Scientific computing on GPUs

(Hanrahan)

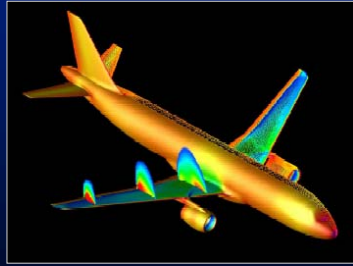
- 3GHz Pentium P4 SSE
– 6 GFLOPs
- ATI X800XT (R420) fragment processor:
 $520 \text{ Mhz} * 16 \text{ pipes} * 4 \text{ wide} * 1 \text{ flop/inst} * 1 \text{ inst/cycle}$
= 66.5 GFLOPs
- key challenge: how to program GPUs?

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Stream programming on GPUs



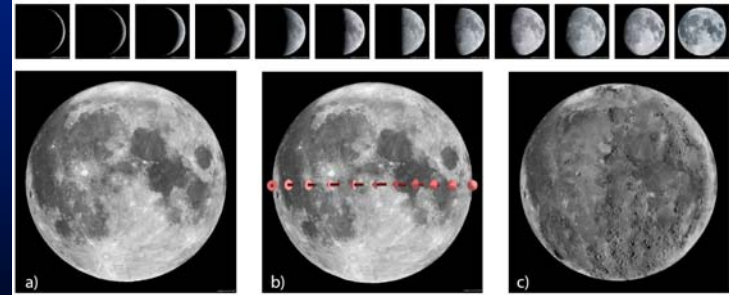
molecular dynamics
folding@home



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)

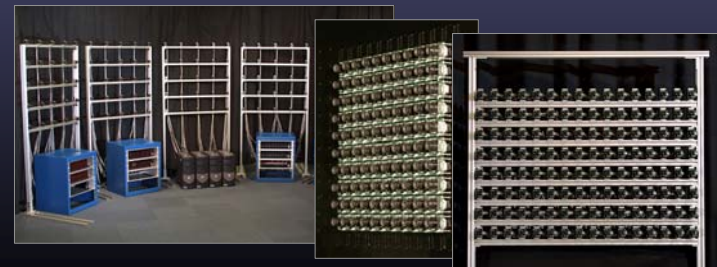


- 640×480 pixels \times
30 fps \times 128 cameras
- synchronized timing
- continuous streaming
- flexible arrangement

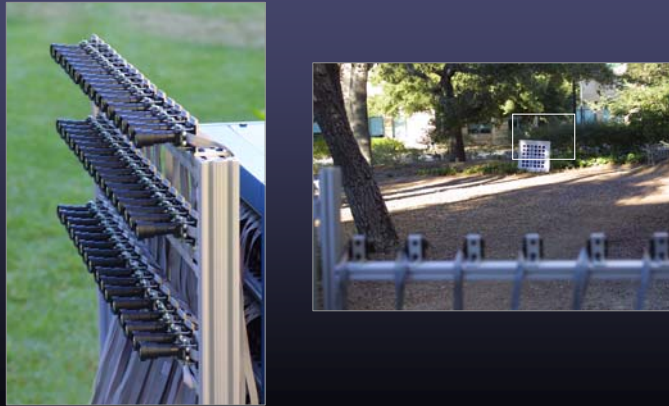


Ways to use large camera arrays

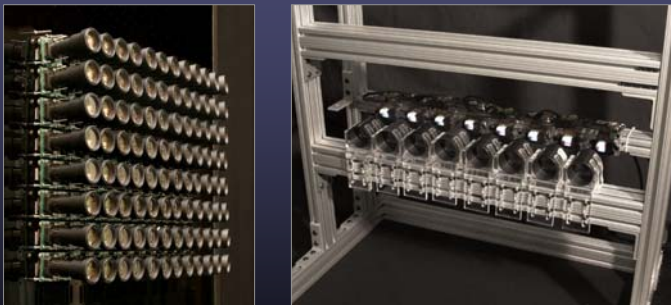
- widely spaced \rightarrow light field capture
- tightly packed \rightarrow high-performance imaging
- intermediate spacing \rightarrow synthetic aperture photography



Example of synthetic aperture photography

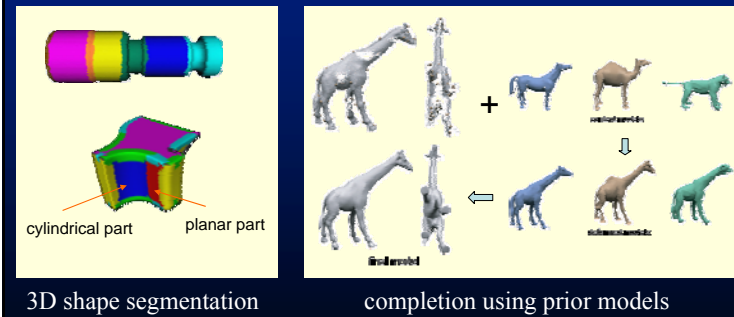


Arrays of cameras and projectors



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

Algorithms for point clouds (Guibas)



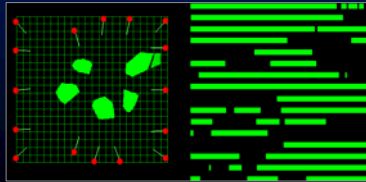
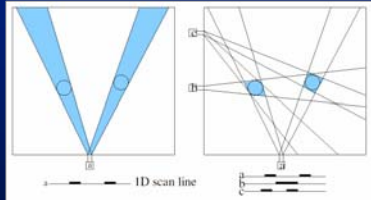
3D shape segmentation

completion using prior models

Geometric reasoning for networks of cameras

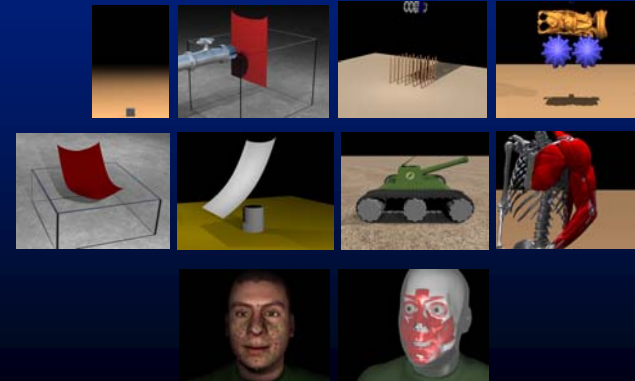
(Guibas)

- 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

Multiperspective panoramas

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



Multiperspective panoramas



Multiperspective 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”



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