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
125 μ square-sided microlenses

Examples of digital refocusing
Refocusing portraits

Misfocused camera

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

- 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

- estimate spatial occupancy by sharing occlusion maps across multiple cameras

Physics-based modeling and simulation

The Stanford CityBlock Project

- 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

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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