

Computational Photography

Digital Visual Effects, Spring 2009

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Computational photography

wikipedia:

Computational photography refers broadly to computational imaging techniques that enhance or extend the capabilities of digital photography. The output of these techniques is an ordinary photograph, but one that could not have been taken by a traditional camera.

What is computational photography



- Convergence of image processing, computer vision, computer graphics and photography
- Digital photography:
 - Simply mimics traditional sensors and recording by digital technology
 - Involves only simple image processing
- Computational photography
 - More elaborate image manipulation, more computation
 - New types of media (panorama, 3D, etc.)
 - Camera design that take computation into account

Computational photography

- One of the most exciting fields.
- [Symposium on Computational Photography and Video](#), 2005
- Full-semester courses in MIT, CMU, Stanford, GaTech, University of Delaware
- A new book by Raskar and Tumblin in SIGGRAPH 2007.
- [IEEE International Conference on computational Photography](#), San Francisco, 2009.

Siggraph 2006 Papers (16/86=18.6%)

Hybrid Images

Drag-and-Drop Pasting

Two-scale Tone Management for Photographic Look

Interactive Local Adjustment of Tonal Values

Image-Based Material Editing

Flash Matting

Natural Video Matting using Camera Arrays

Removing Camera Shake From a Single Photograph

Coded Exposure Photography: Motion Deblurring

Photo Tourism: Exploring Photo Collections in 3D

AutoCollage

Photographing Long Scenes With Multi-Viewpoint Panoramas

Projection Defocus Analysis for Scene Capture and Image Display

Multiview Radial Catadioptric Imaging for Scene Capture

Light Field Microscopy

Fast Separation of Direct and Global Components of a Scene Using High Frequency Illumination

Siggraph 2007 Papers (23/108=21.3%)

Image Deblurring with Blurred/Noisy Image Pairs
Photo Clip Art
Scene Completion Using Millions of Photographs
Soft Scissors: An Interactive Tool for Realtime High Quality Matting
Seam Carving for Content-Aware Image Resizing
Detail-Preserving Shape Deformation in Image Editing
Veiling Glare in High Dynamic Range Imaging
Do HDR Displays Support LDR content? A Psychophysical Evaluation
Ldr2hdr: On-the-fly Reverse Tone Mapping of Legacy Video and Photographs
Rendering for an Interactive 360-Degree Light Field Display
Multiscale Shape and Detail Enhancement from Multi-light Image Collections
Post-Production Facial Performance Relighting Using Reflectance Transfer
Active Refocusing of Images and Videos
Multi-aperture Photography
Dappled Photography: Mask-Enhanced Cameras for Heterodyned Light Fields and Coded Aperture Refocusing
Image and Depth from a Conventional Camera with a Coded Aperture
Capturing and Viewing Gigapixel Images
Efficient Gradient-Domain Compositing Using Quadrees
Image Upsampling via Imposed Edges Statistics
Joint Bilateral Upsampling
Factored Time-Lapse Video
Computational Time-Lapse Video
Real-Time Edge-Aware Image Processing With the Bilateral Grid

Siggraph 2009 Papers (17/78=21.8%)



[Gaussian KD-Trees for Fast High-Dimensional Filtering](#)

[Edge-Avoiding Wavelets and their Applications](#)

[Multi-operator Media Retargeting](#)

[PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing](#)

[Modeling Human Color Perception under Extended Luminance Levels](#)

[Moving Gradients: A Path-Based Method for Plausible Image Interpolation](#)

[Optimizing Content-Preserving Projections for Wide-Angle Images](#)

[Content-Preserving Warps for 3D Video Stabilization](#)

[Visio-lization: Generating Novel Facial Images](#)

[Coordinates for Instant Image Cloning](#)

[SkyFinder: Attribute-based Sky Image Search](#)

[Paint Selection](#)

[Video SnapCut: Robust Video Object Cutout Using Localized Classifiers](#)

[Invertible Motion Blur in Video](#)

Dark Flash Photography

[4D Frequency Analysis of Computational Cameras for Depth of Field Extension](#)

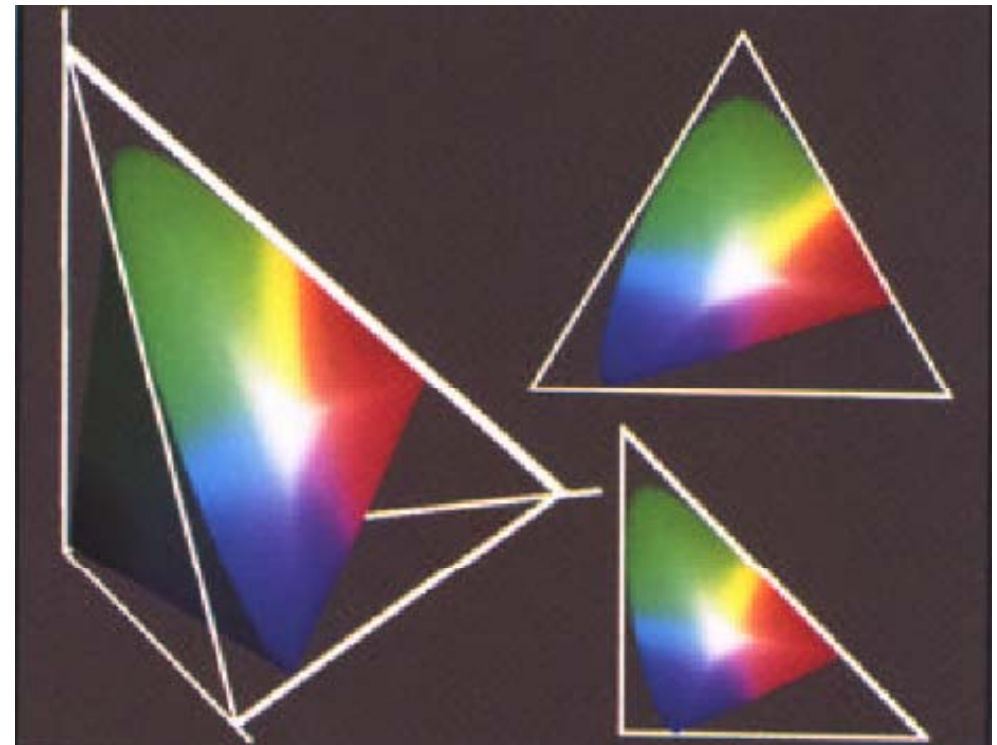
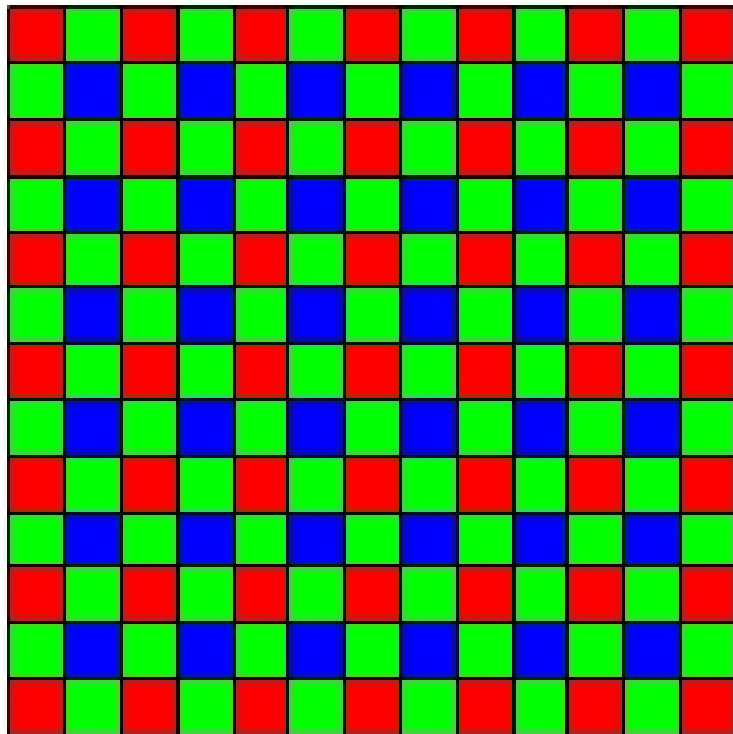
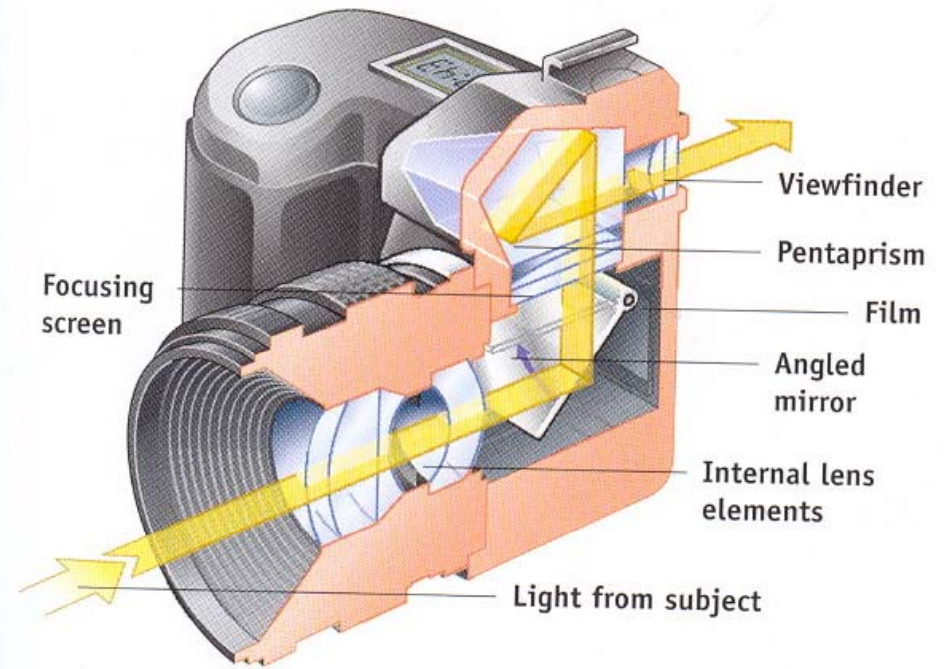
Bokode: Imperceptible Visual Tags for Camera-based Interaction from a Distance

Scope

- We can't yet set its precise definition. The following are scopes of what researchers are exploring in this field.
 - Record a richer visual experience
 - Overcome long-standing limitations of conventional cameras
 - Enable new classes of visual signal
 - Enable synthesis impossible photos

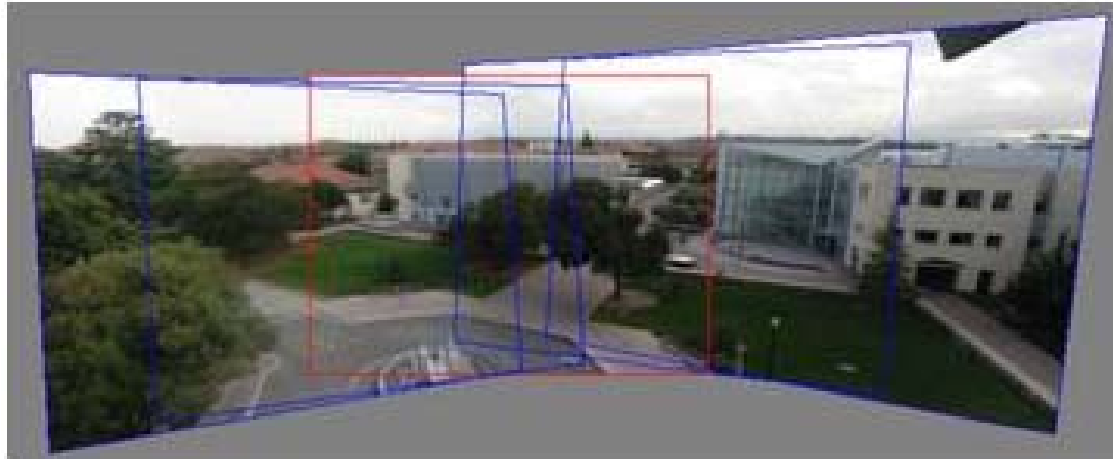
Scope

- Image formation
- Color and color perception

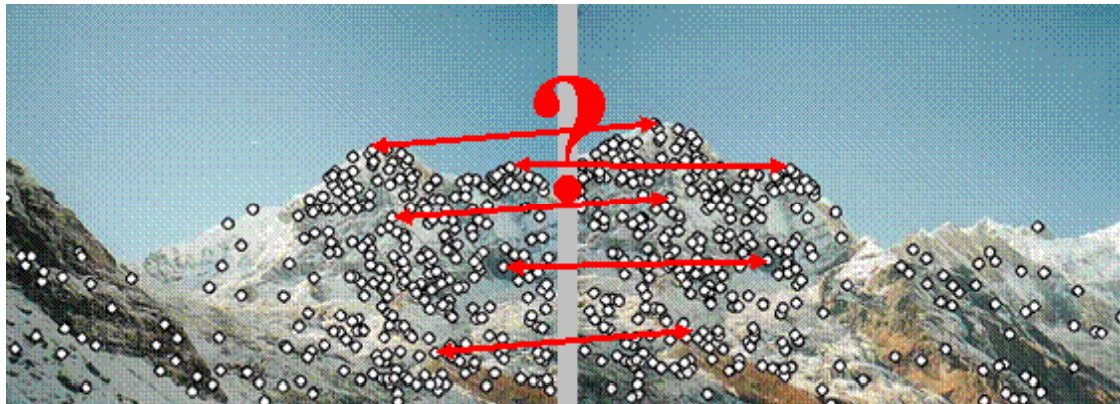


Scope

- Panoramic imaging



- Image and video registration



- Spatial warping operations



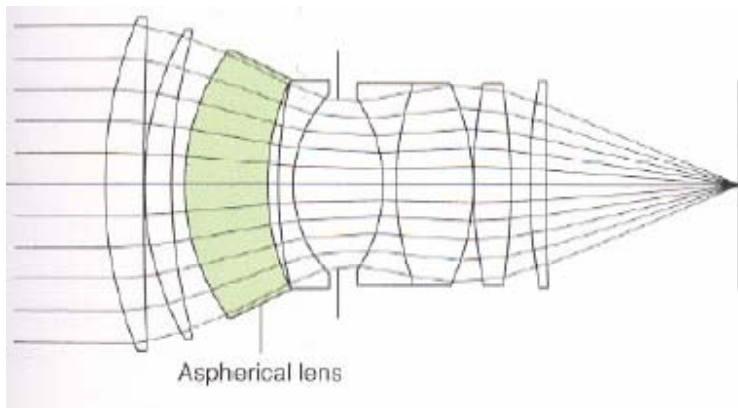
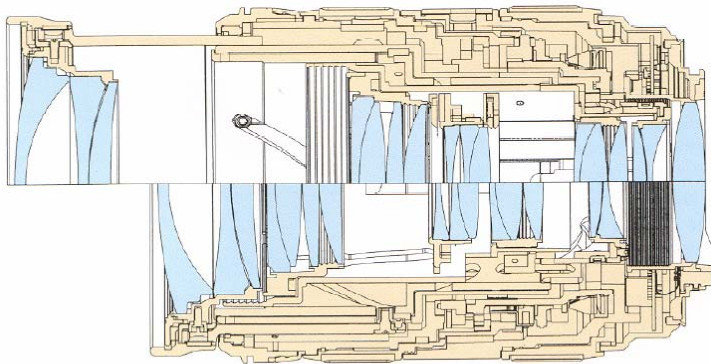
Scope

- High Dynamic Range Imaging
- Bilateral filtering and HDR display
- Matting

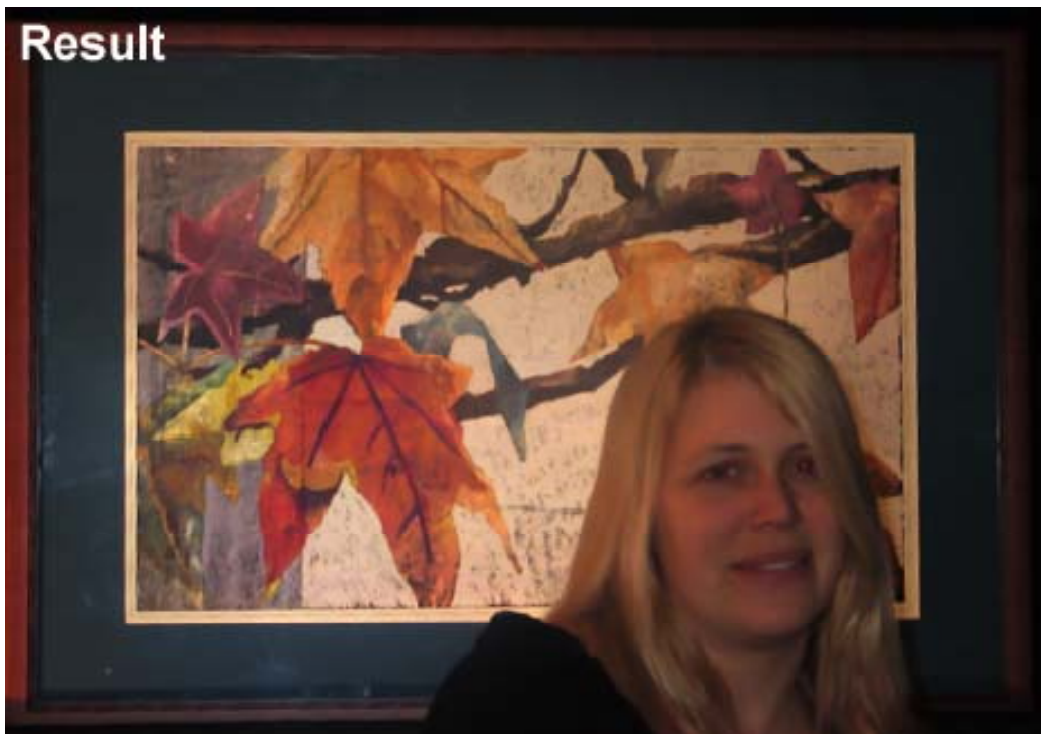
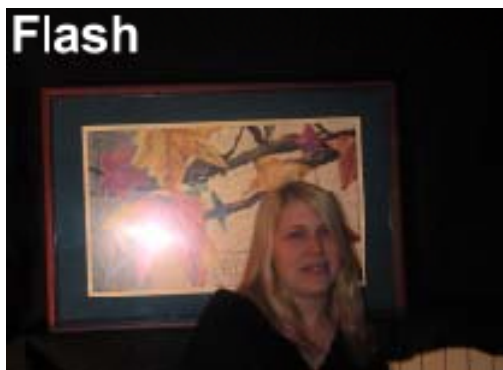
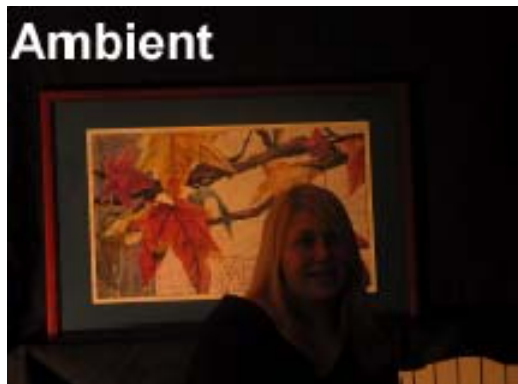


Scope

- Active flash methods
- Lens technology
- Depth and defocus



Removing Photography Artifacts using Gradient Projection and Flash-Exposure Sampling



Continuous flash



Flash = 0.0



Flash = 1.0



Flash = 0.3



Flash = 0.7

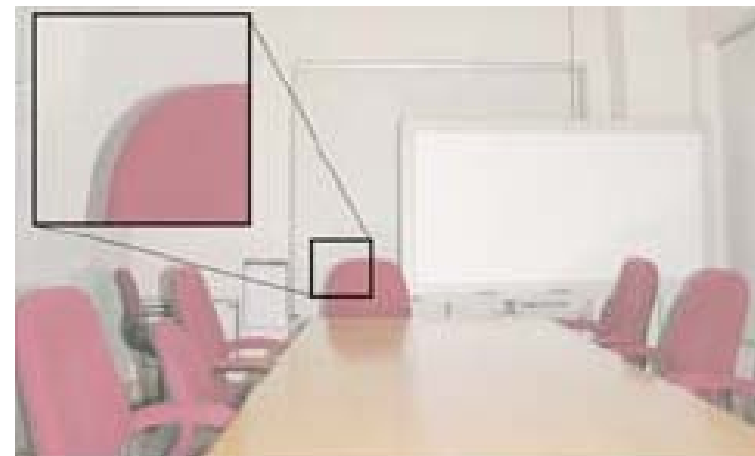
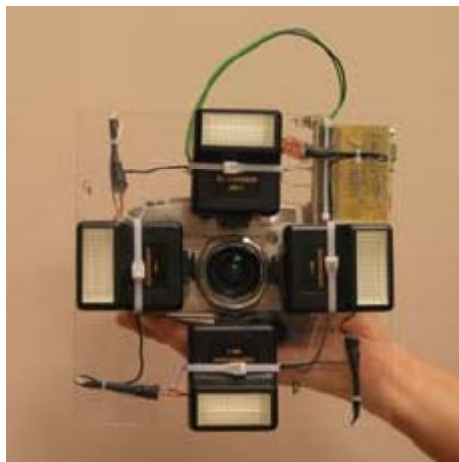


Flash = 1.4

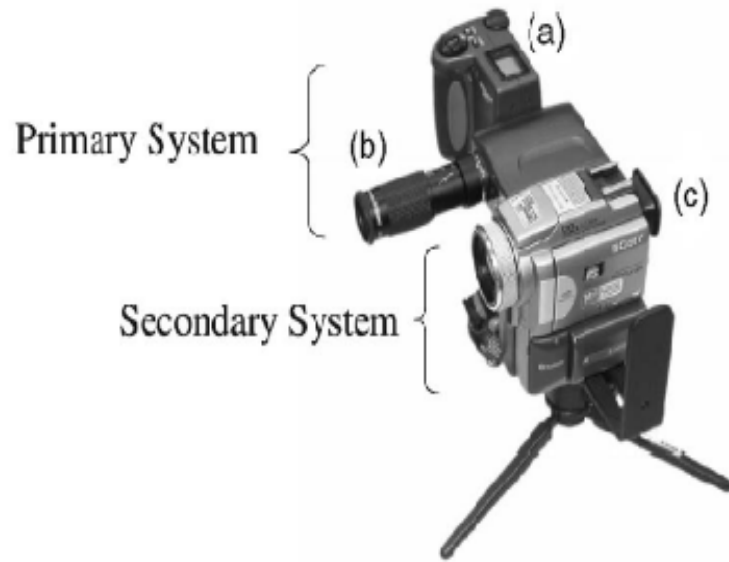
Flash matting



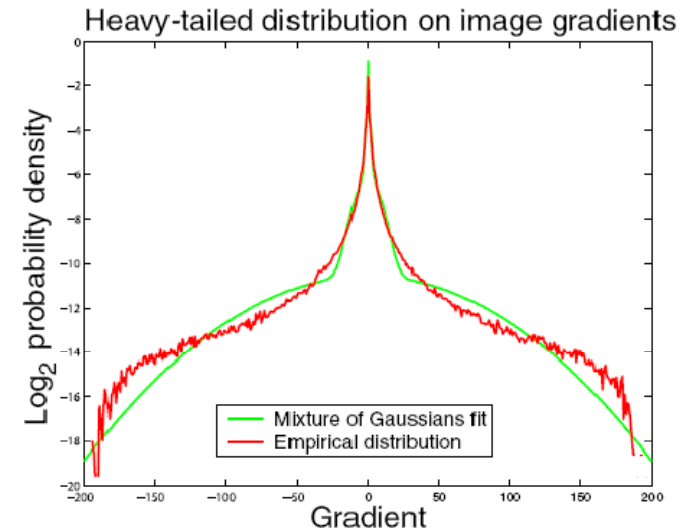
Depth Edge Detection and Stylized Rendering Using a Multi-Flash Camera



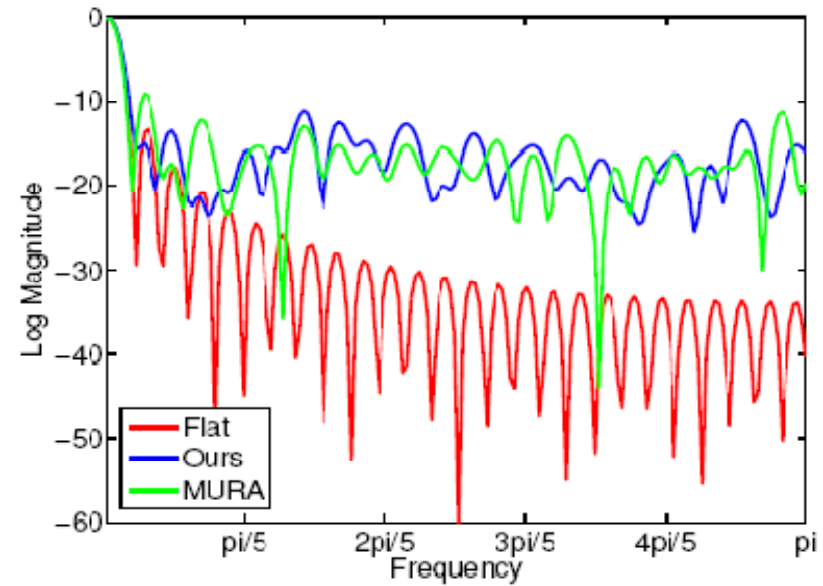
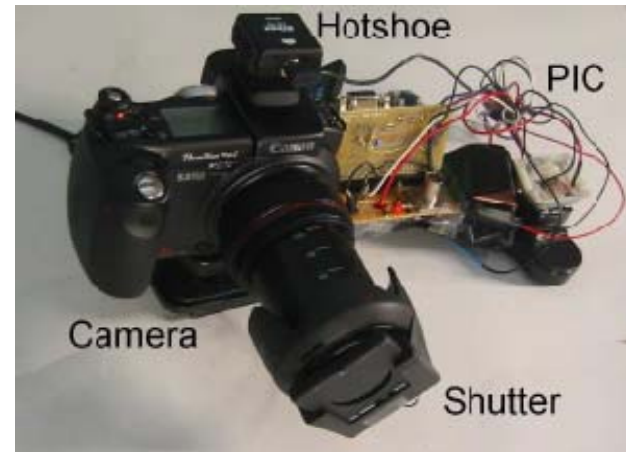
Motion-Based Motion Deblurring



Removing Camera Shake from a Single Photograph

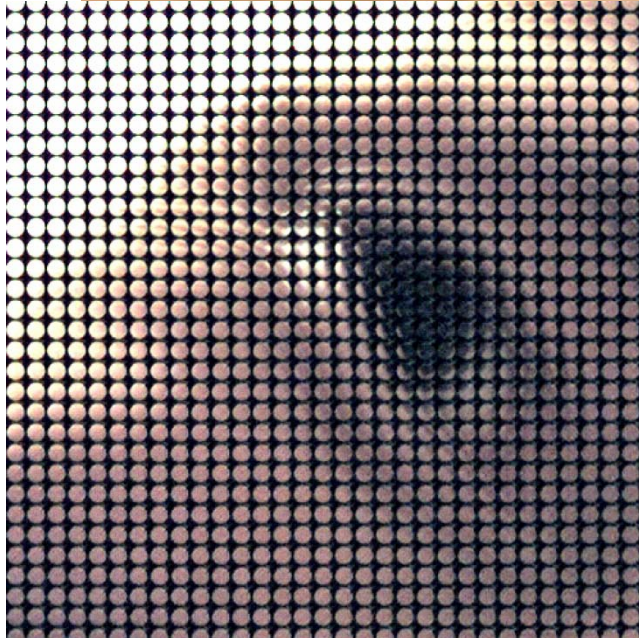
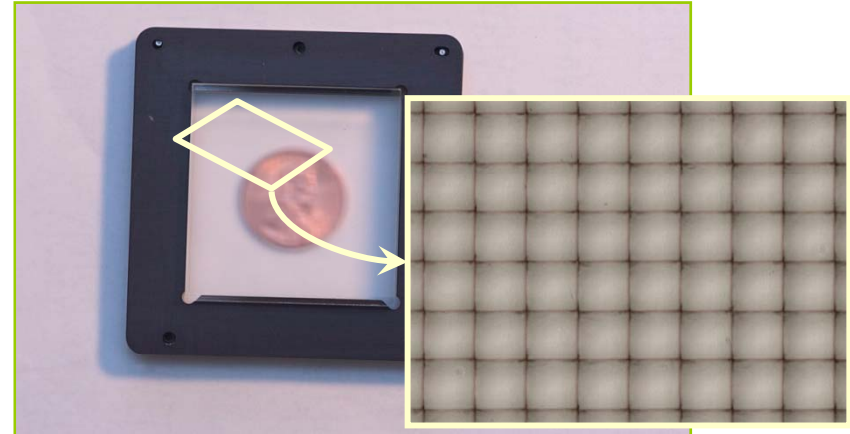


Motion Deblurring using Fluttered Shutter



Scope

- Future cameras
- Plenoptic function and light fields



Scope

- Gradient image manipulation



sources/destinations



cloning



seamless cloning

Scope

- Taking great pictures



Art Wolfe



Ansel Adams

Scope

- Non-parametric image synthesis, inpainting, analogies

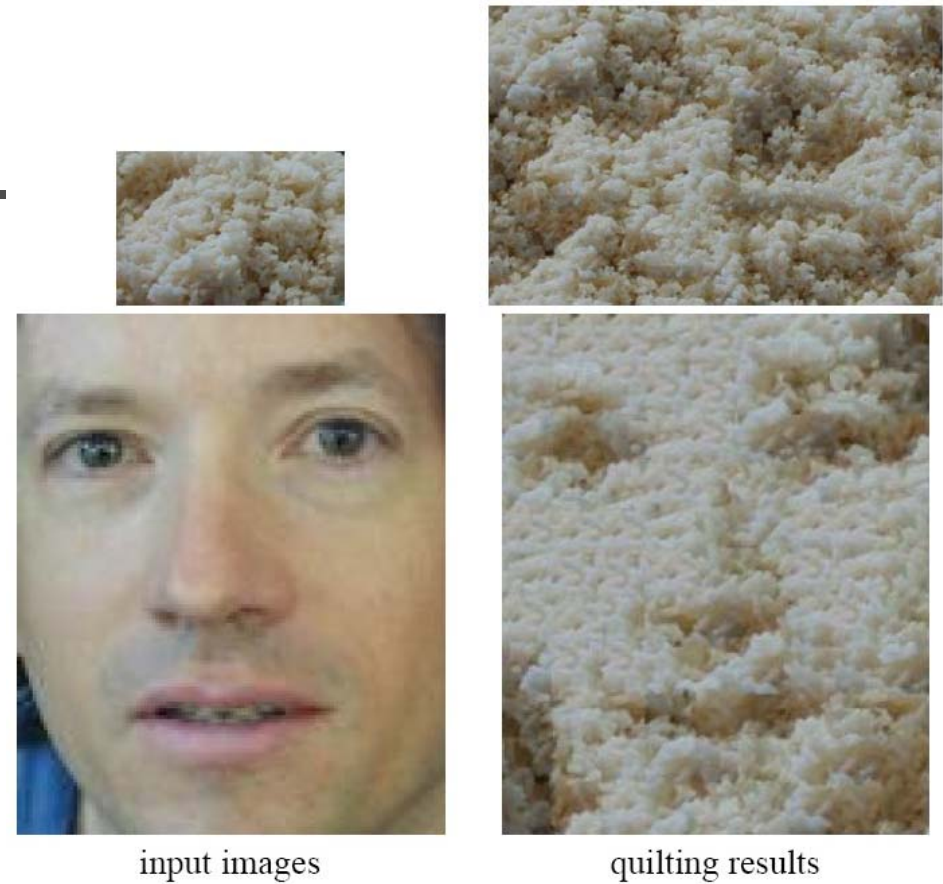


Figure 1 An image analogy. Our problem is to compute a new “analogous” image B' that relates to B in “the same way” as A' relates to A . Here, A , A' , and B are inputs to our algorithm, and B' is the output. The full-size images are shown in Figures 10 and 11.

Scope

Motion
analysis

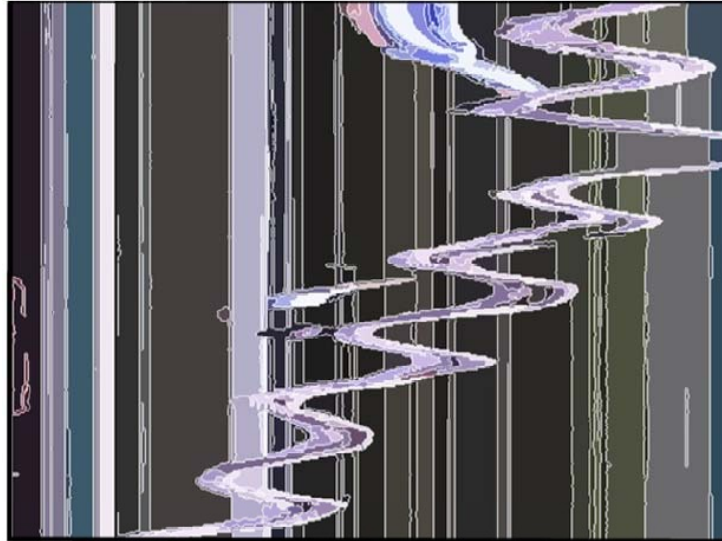


Image Inpainting



Object Removal by Exemplar-Based Inpainting

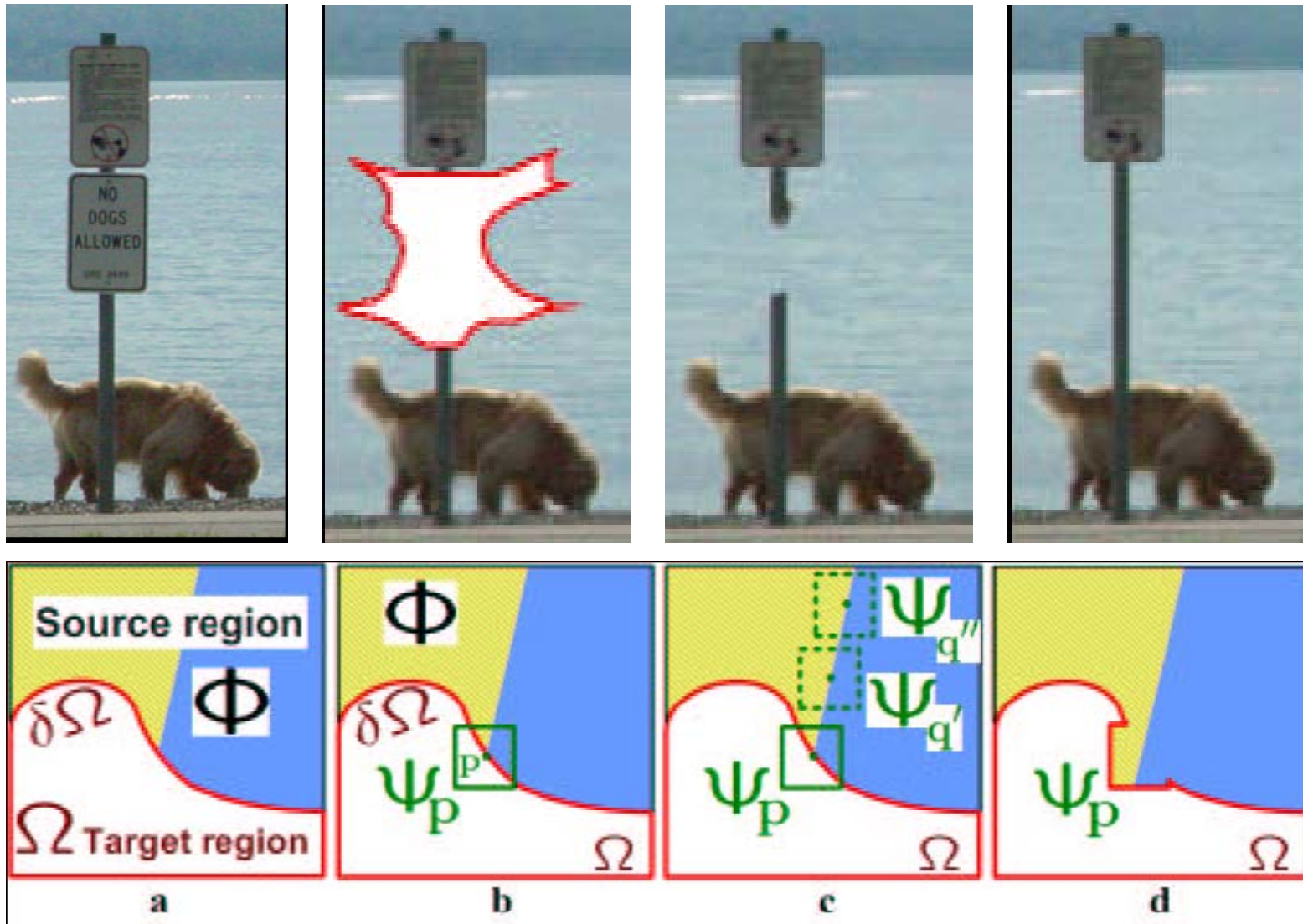
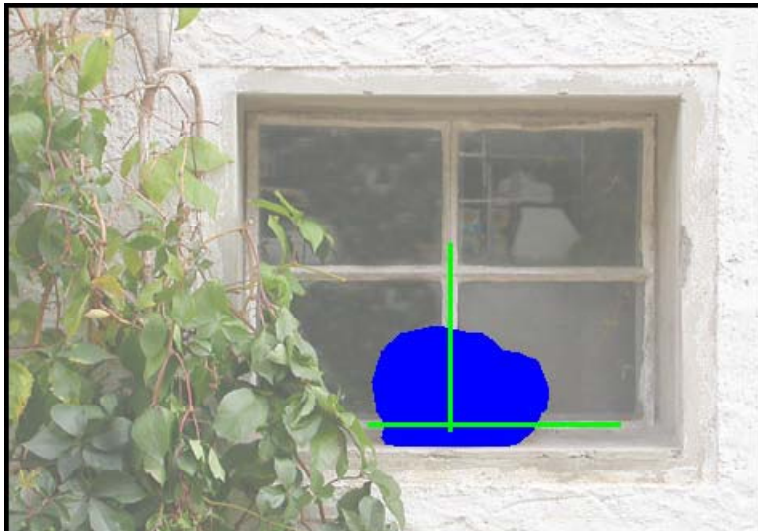


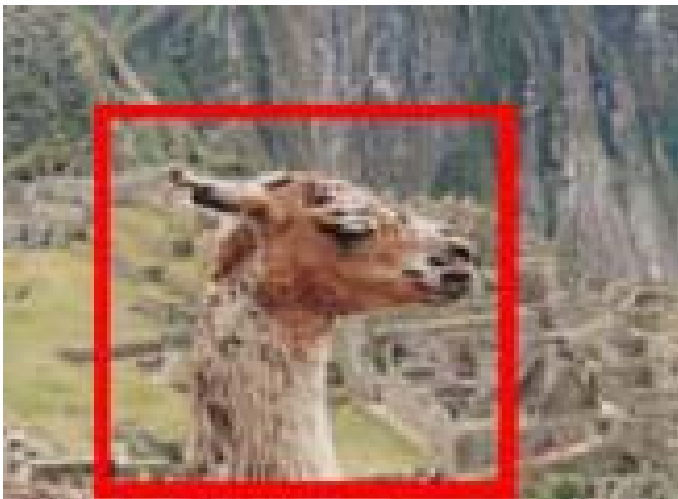
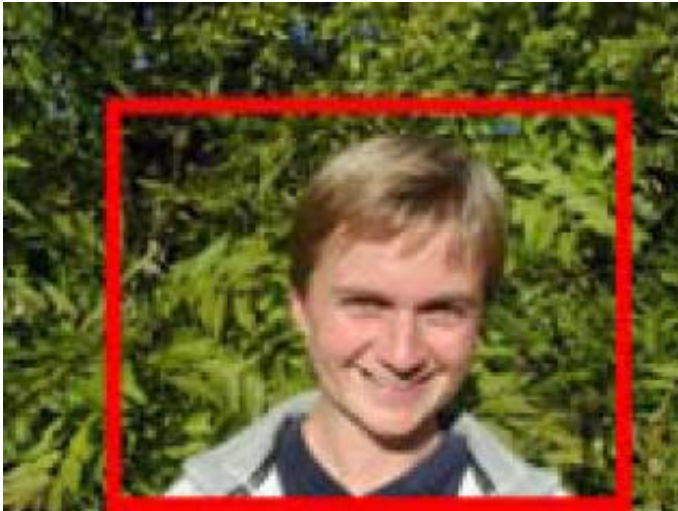
Image Completion with Structure Propagation



Lazy snapping



Grab Cut - Interactive Foreground Extraction using Iterated Graph Cuts



Tools

- Graph cuts,
 - Segmentation and mosaicing
- Gradient domain operations,
 - Tone mapping, fusion and matting
- Bilateral filters,
 - Denoising, image enhancement