

# Course Schedule and Syllabus

## Morning

1. 08:30 - 08:50, 20 minutes (Debevec)

### Introduction and Overview

1. What is image-based modeling and rendering (IBMR)
2. Differences between image-based modeling and rendering and traditional 3D graphics
3. Why this is a promising area
4. Some Examples
5. Advantages and disadvantages
6. The spectrum of IBMR - from image indexing to 3D scanning

2. 08:50 - 10:00, 70 minutes (Sillion)

### Image Formation Fundamentals and Using IBMR to Accelerate Rendering

1. What is an image?
2. Simple projective geometry, and the pin-hole camera model
3. How light interacts with matter
4. The relationship of global illumination to IBMR
5. Challenges posed by non-diffuse reflectance
6. Image caching techniques
7. Affine sprite warping

### Break

3. 10:15 - 11:00, 45 Minutes (Szeliski)

### Determining Geometry from Images

1. Why geometry is useful for image-based rendering
2. Computer Vision as Inverse Computer Graphics
3. Notes on camera calibration
4. Computing depth maps with stereo and multi-baseline stereo
5. Image correspondence techniques
6. Structure from Motion
7. Overview of other methods: Photogrammetric Modeling, 3D Scanning

**Note:** Additional material on determining geometry from images is available in the course notes for Course #28, *3D Photography*. Topics covered in detail include photogrammetric modeling, silhouette-based methods, 3D laser scanning, and other active sensing methods.

4. 11:00 - 12:00, 60 Minutes (McMillan)

### 2D and 3D Image Warping

1. Image mosaicing and cylindrical panoramic viewing
2. Explanation of a depth map
3. Ways to warp an image based on depth
4. Panoramic image warping
5. Turning images and depth into a navigable environment

Lunch (12:00 - 01:30)

## Afternoon

5. 01:30 - 02:20, 50 Minutes (Cohen)

### LDI and Lightfield / Lumigraph representations

1. What is an image versus what is a model?
2. Layered depth images (LDIs)
3. The plenoptic function
4. Reduction to 4D
5. Light field rendering and the Lumigraph
6. Combining light fields with geometry
  - Silhouette models (Lumigraph)
  - View-dependent texture-mapping (Façade)

6. 02:20 - 03:00, 40 Minutes (Debevec)

### Image-Based Lighting

1. Recovering lighting information from photographs
  - High dynamic range photography / light probes / inverse lighting
2. Illuminating synthetic objects with real light
3. Making additions and modifications to image-based models maintaining correct global illumination
4. Inverse global illumination: recovering material properties of real scenes from photographs
5. Communicating the sense of brightness using post-processing operations
6. The Light Stage: illuminating real objects/people with recorded light for compositing

Break

7. 03:15 - 04:05, 50 Minutes (Bregler)

### Applications of IBMR in human animation

1. How IBMR generalizes from 3D navigation to kinematic domains
2. Facial animation with image-based rendering
3. Human figure animation with image-based modeling

8. 04:05 - 04:40, 35 Minutes (Debevec)

### Applications of IBMR in Art and Cinema

1. Matte paintings vs. 3D Models in Movies (Gone with the Wind / Star Wars)
2. The Aspen and San Francisco Movie Map projects (Lippman)
3. Naimark's "Displacements" - physically projecting images onto geometry
4. Dayton Taylor's Timetrack system & "jump morphing"
5. Rouen Revisited (SIGGRAPH 96 art show), Mona Lisa Morph (SIGGRAPH 96),  
Buf Compagnie's Like a Rolling Stone (SIGGRAPH 96),  
Tour into the Picture (SIGGRAPH 97); What Dreams May Come (1998),  
The Matrix (1999); Prince of Egypt (1999)

9. 04:40 - 05:00, 20 Minutes (Everyone)

### Questions and Dialog

# Table of Contents

## 1. Introduction and Overview

Notes: *What is Image-based Modeling and Rendering?* (Debevec)

Slides: Introduction to Image-Based Modeling, Rendering, and Lighting (Debevec)

## 2. Fundamentals of Image Formation and Re-Use

Notes: *Fundamentals of image formation and re-use* (Sillion)

Slides: Fundamentals of image formation and re-use (Sillion)

Paper: *Rendering With Coherent Layers*  
Jed Lengyel and John Snyder, Proc. SIGGRAPH 97

Paper: *Multi-layered impostors for accelerated rendering*  
Xavier Decoret, Gernot Schaufler, François Sillion, and Julie Dorsey, Proc. Eurographics 1999

Paper: *A Three Dimensional Image Cache for Virtual Reality*  
Gernot Schaufler and Wolfgang Stürzlinger, Proc. Eurographics 1996

## 3. Determining Geometry from Images

Slides: Determining Geometry from Images (Szeliski)

Paper: *From images to models (and beyond): a personal retrospective*  
Richard Szeliski, Proc. Vision Interface 1997

Paper: *Modeling and Rendering Architecture from Photographs:  
A hybrid geometry- and image-based approach*  
Paul E. Debevec Camillo J. Taylor, and Jitendra Malik, Proc. SIGGRAPH 96

Note: Additional material on determining geometry from images is available in the course notes for Course #28, *3D Photography*. Topics covered in detail include photogrammetric modeling, silhouette-based methods, 3D laser scanning, and other active sensing methods.

## 4. 2D and 3D Image Warping

Notes: *Image-Based Rendering using Image Warping* (McMillan)

Notes: *Computing Visibility without Depth* (McMillan)

Slides: Image-Based Rendering using Image Warping (McMillan)

Paper: *Plenoptic Modeling*  
Leonard McMillan and Gary Bishop, Proc. SIGGRAPH 95

Paper: *View Morphing*  
Steven M. Seitz and Charles R. Dyer, Proc. SIGGRAPH 96

## 5. LDI and Lightfield / Lumigraph representations

- Slides: *The Lumigraph (Cohen)*  
Slides prepared by Steven P. Gortler
- Paper: *Layered Depth Images*  
Jonathan Shade, Steven Gortler, Li-wei Hey, and Richard Szeliski, Proc. SIGGRAPH 97
- Paper: *Light Field Rendering*  
Marc Levoy and Pat Hanrahan, Proc. SIGGRAPH 96
- Paper: *The Lumigraph*  
S. J. Gortler, R. Grzeszczuk, R. Szeliski, and M. F. Cohen, Proc. SIGGRAPH 96
- Paper: *Efficient View-Dependent Image-Based Rendering with Projective Texture-Mapping*  
Paul Debevec, George Borshukov, and Yizhou Yu, 9th Eurographics Rendering Workshop, 1998

## 6. Image-Based Lighting

- Slides: *Image-Based Lighting (Debevec)*
- Paper: *Recovering High Dynamic Range Radiance Maps from Photographs.*  
Paul E. Debevec and Jitendra Malik, Proc. SIGGRAPH 97
- Paper: *Rendering Synthetic Objects into Real Scenes: Bridging Traditional and Image-Based Graphics with Global Illumination and High Dynamic Range Photography*  
Paul Debevec, Proc. SIGGRAPH 98

## 7. Applications of IBMR in Human Animation

- Notes: *Video Based Animation Techniques for Human Motion (Bregler)*
- Slides: *IBMR Techniques for Animating People (Bregler)*
- Paper: *Video Rewrite: Driving Visual Speech with Audio*  
Christoph Bregler, Michele Covell, Malcolm Slaney, Proc. SIGGRAPH 97
- Paper: *Synthesizing Realistic Facial Expressions from Photographs*  
Frédéric Pighin, Jamie Hecker, Dani Lischinski, Richard Szeliski, and David H. Salesin, Proc. SIGGRAPH 98
- Paper: *Making Faces*  
Brian Guenter, Cindy Grimm, Daniel Wood, Henrique Malvar, and Fredrick Pighin, Proc. SIGGRAPH 98
- Paper: *Video Motion Capture*  
Christoph Bregler and Jitendra Malik

## 8. Applications of IBMR in Art and Cinema

- Slides: *Applications of IBMR in Art and Cinema (Debevec)*
- Notes: *Rouen Revisited*  
Golan Levin and Paul Debevec