

# Image Based Rendering

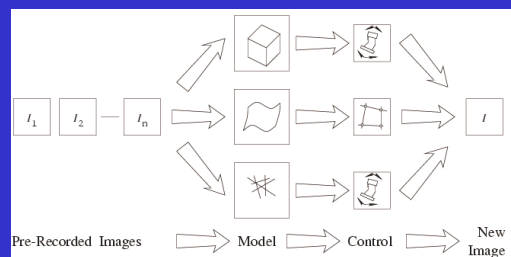
## What is Image Based Rendering?

- The synthesis of new views of a scene from pre-recorded images.
- Used in entertainment industry: films, postproduction, games, etc.

### Three approaches for Image Based Rendering:

1. Image-Based Rendering from Registered Images (3D Model construction)
2. Image-Based Rendering from Motion Sequences
3. The Light Field

### Image-Based Rendering

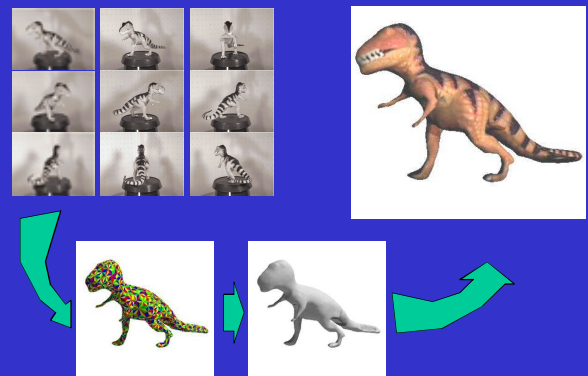


### 1. Image-Based Rendering from Registered Images (3D Model construction)

Volumetric Models -- Visual Hulls



Reprinted from "Automatic Model Construction, Pose Estimation, and Object Recognition from Photographs Using Triangular Splines,"  
By S. Sullivan and J. Ponce, IEEE Trans. on Pattern Analysis and Machine Intelligence, 20(10):1091-1096, (1998). © 1998 IEEE.

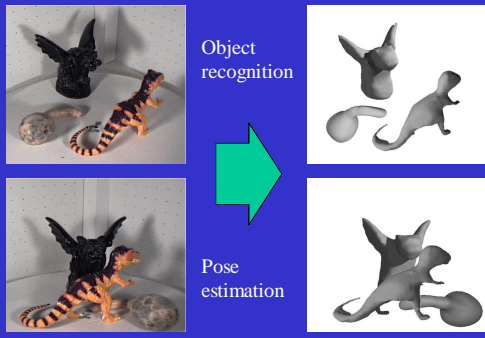


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By S. Sullivan and J. Ponce, IEEE Trans. on Pattern Analysis and Machine Intelligence, 20(10):1091-1096, (1998). © 1998 IEEE.



And More..

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By S. Sullivan and J. Ponce, IEEE Trans. on Pattern Analysis and Machine Intelligence, 20(10):1091-1096 (1998). © 1998 IEEE.




Object recognition

Pose estimation

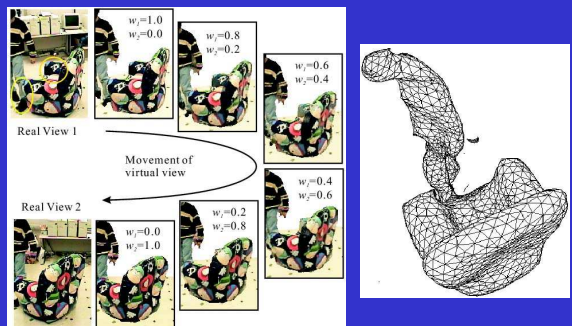
Reprinted from "Automatic Model Construction, Pose Estimation, and Object Recognition from Photographs Using Triangular Splines,"  
By S. Sullivan and J. Ponce, IEEE Trans. on Pattern Analysis and Machine Intelligence, 20(10):1091-1096 (1998). © 1998 IEEE.

Another Approach: Virtualized Reality (Kanade, 1997)




Reprinted from "Virtualized Reality: Constructing Virtual Worlds from Real Scenes," by T. Kanade, P.W. Rander, and J.P. Narayanan, IEEE Multimedia, 4(1):34-47 (1997). © 1997 IEEE.

More Virtualized Reality..



Reprinted from "Appearance-Based Virtual View Generation of Temporally-Varying Events from Multi-Camera Images in the 3D Room," by H. Saito, S. Baba, M. Kimura, S. Vedula, and T. Kanade, Tech. Rep. CMU-CS-99-127, School of Computer Science, Carnegie-Mellon University, 1999.

Another approach: use unregistered images  
Façade (Debevec, Taylor and Malik, 1996)

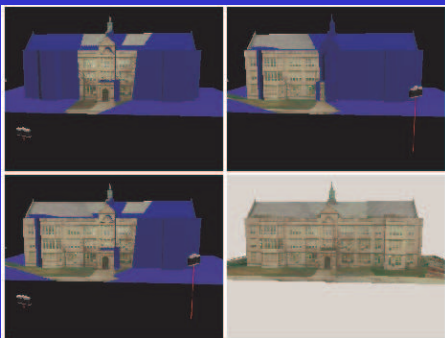


Architectural modeling:

- photogrammetry;
- view-dependent texture mapping;
- model-based stereopsis.

Reprinted from "Modeling and Rendering Architecture from Photographs: A Hybrid Geometry- and Image-Based Approach,"  
By P. Debevec, C.J. Taylor, and J. Malik, Proc. SIGGRAPH (1996). © 1996 ACM, Inc. Included here by permission.

View-Dependent Texture Mapping

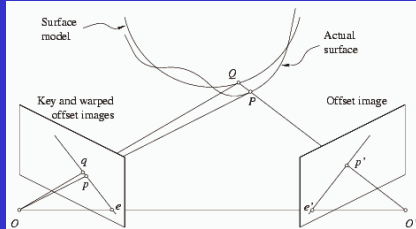


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Model-Based Stereopsis



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2. Transfer based approaches

- No 3D explicit model
- Create a new view from given views

Affine Transfer (Kutulakos and Vallino, 1998)

$$p = AP + b, \text{ where } A = \begin{pmatrix} a_1^T \\ a_2^T \end{pmatrix}$$



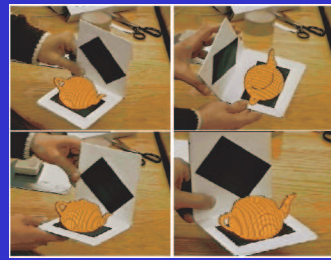
Pick  $P_0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, P_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, P_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, P_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$

$$b = p_0$$

$$p = AP + b = \begin{pmatrix} a_1^T \\ a_2^T \end{pmatrix} [P_1 | P_2 | P_3] \begin{pmatrix} x \\ y \\ z \end{pmatrix} + b$$



$$p = (1 - x - y - z)p_0 + xp_1 + yp_2 + zp_3$$



Reprinted from "Calibration-Free Augmented Reality," by K. Kutulakos and J. Vallino, IEEE Trans. On Visualization and Computer Graphics, 4(1):1-20 (1998). © 1998 IEEE.



Augmented Reality Experiments

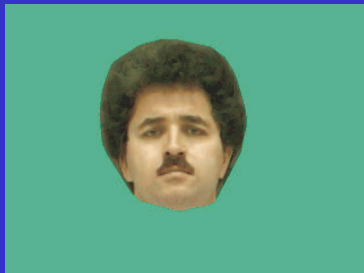
Courtesy of Kyrus Kutulakos

Weak-Perspective/Paraperspective Transfer (Genc and Ponce, 2000)

The weak-perspective (or paraperspective) images of a fixed scene made of  $n$  points form a six-dimensional variety of  $\mathbb{R}^{2n}$



Courtesy of Yakup Genc



Input Clip

Courtesy of Yakup Genc.

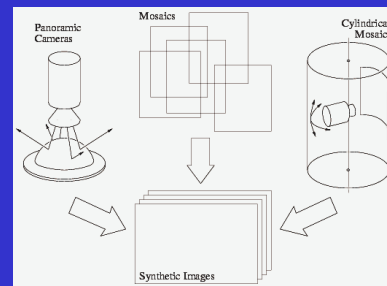


Synthesized Clip

### 3. The Light Field Approach

- Mosaics
- Cylinders
- light field

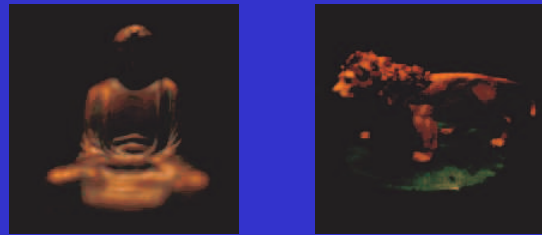
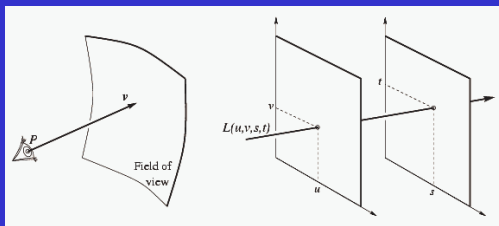
#### View Synthesis Without Motion Analysis



(Peri and Nayar, 1997)  
 (Shum and Szeliski, 1998)  
 (Quicktime VR, Chen, 1995)

#### The Light Field (Levoy and Hanrahan, 1996)

- Images are assembled from two-dimensional subsets of the four-dimensional space formed by light rays.
- Sample the ray space, and make new pictures!



Reprinted from "The Light Field," by M. Levoy and P. Hanrahan, Proc. SIGGRAPH (1996), copyright 1996 ACM, Inc. Included here by permission. Courtesy of Marc Levoy and the Stanford Computer Graphics Laboratory.