# Real Time Rendering

CS 563 Advanced Topics in
Computer Graphics

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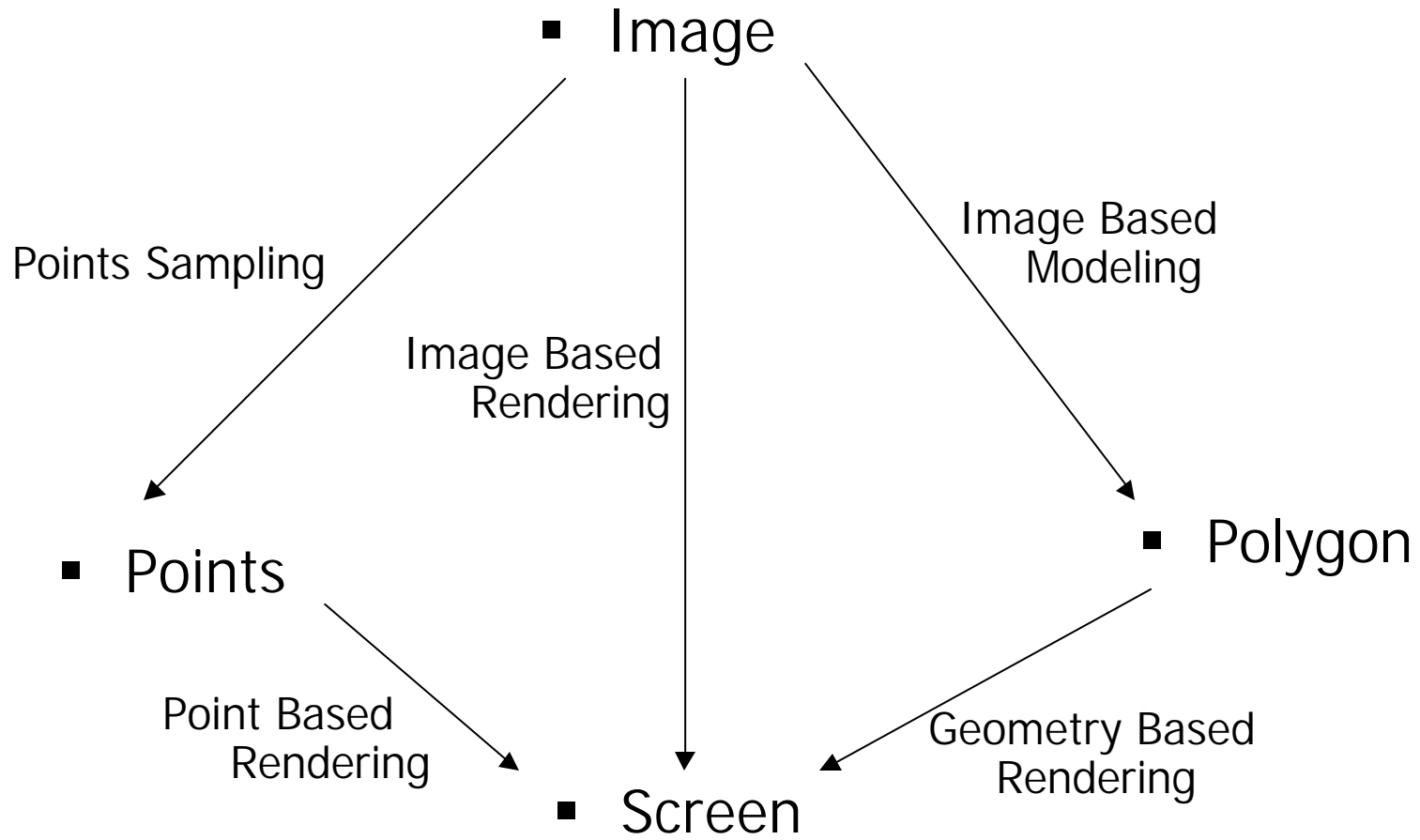
# Introduction

- **Polygon based rendering**
    - Phong modeling
    - Texture mapping
    - Opengl, Directx

- **Point based rendering**
    - VTK

- **Image based rendering**
    - Plenoptic modeling (panorama)
    - Light field
    - BRDF

- Image

Points Sampling

Image Based Modeling

Image Based Rendering

- Points

- Polygon

Point Based Rendering

Geometry Based Rendering
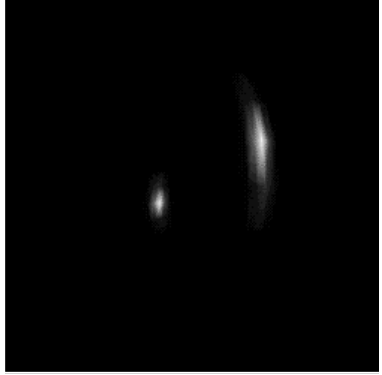
- Screen

- Shading model
  - Gouraud shading model
  - Phong shading model
    - $I_{tot} = I_{amb} + I_{diff} + I_{spec}$



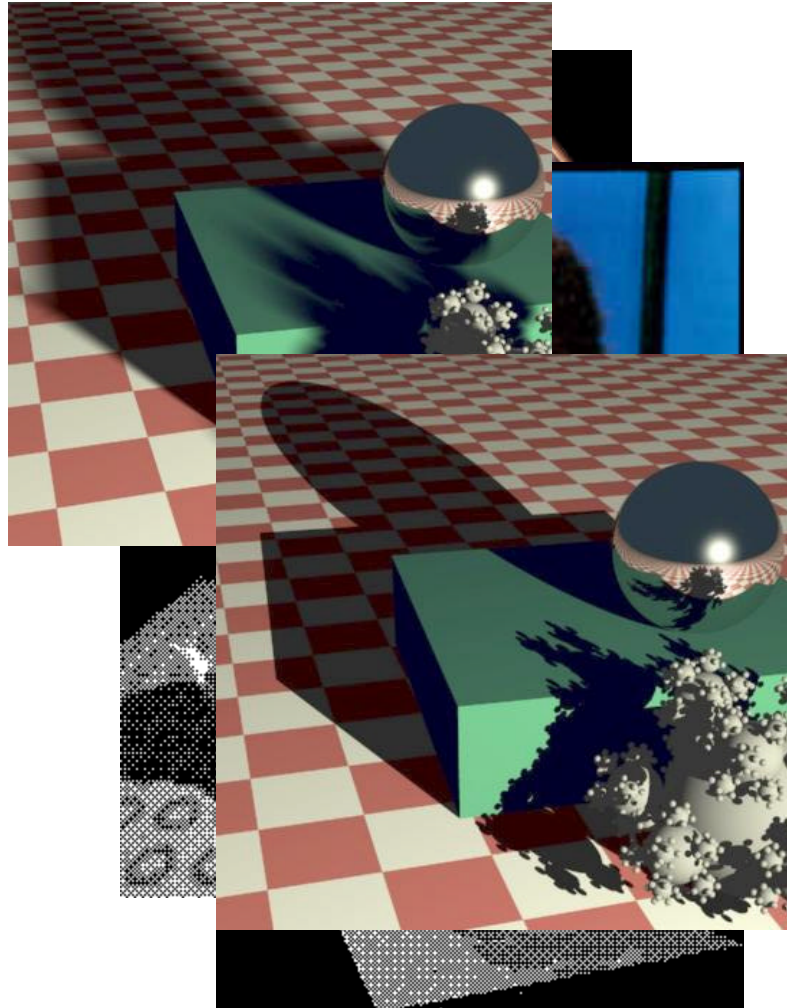Diffuse          +          Specular          =          Combined Image
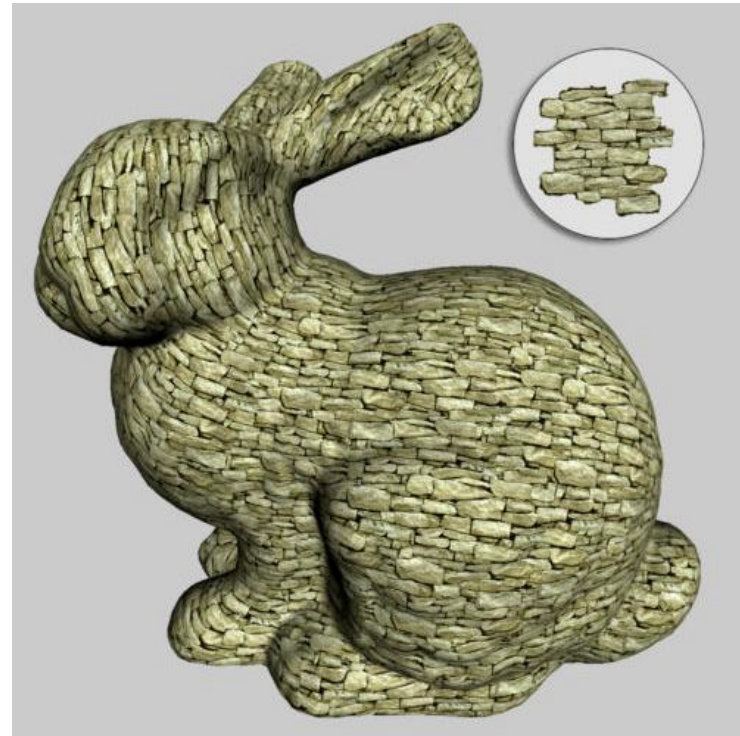
# Global Illumination

- Reflection
  - Environment mapping
  - Ray tracing

- Shadow
  - Planar shadow
  - Self shadow
    - Volume shadow
    - Shadow map
  - Soft shadow

## Texture mapping

- Geometric mapping

- Filtering
  - Box filter
    - Trilinear filter
    - MIPMAP:
      a min or max filter

# Bump map

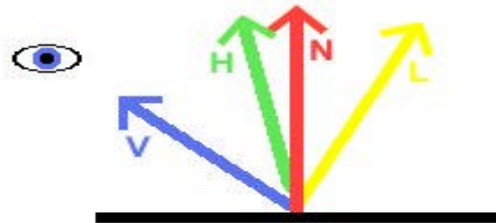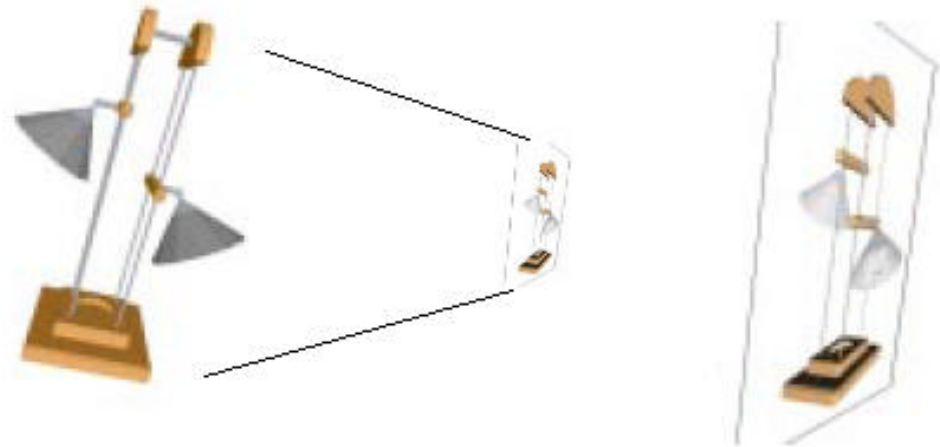- Bump map



- Planar Texture
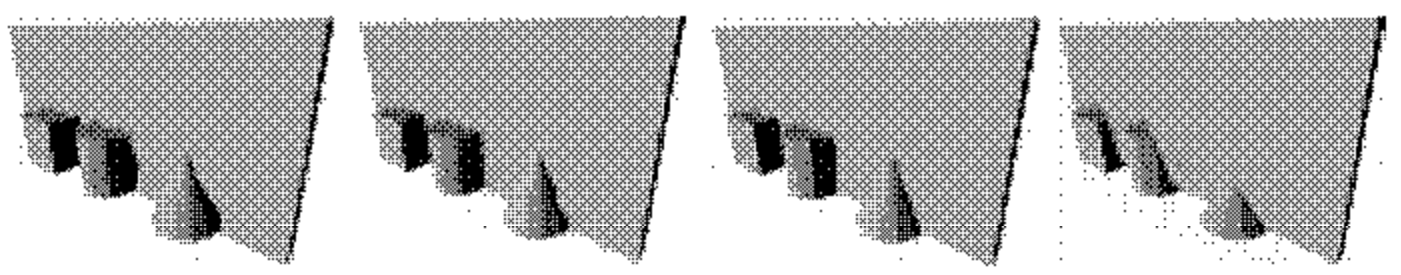


- Bump map Texture

- General image warping
  - LOD and impostor

    

  - Nailboard

    

# Image warping

- Layered impostor
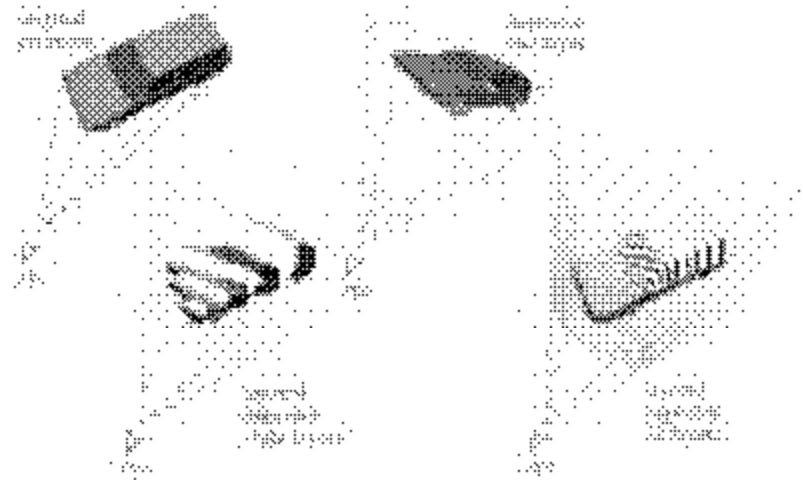
# Image warping

- Layer depth Images
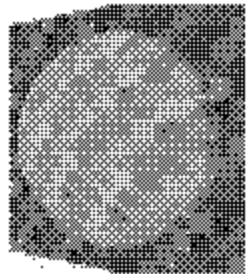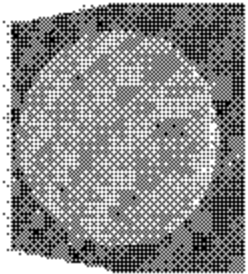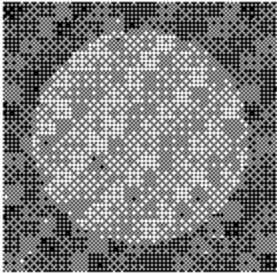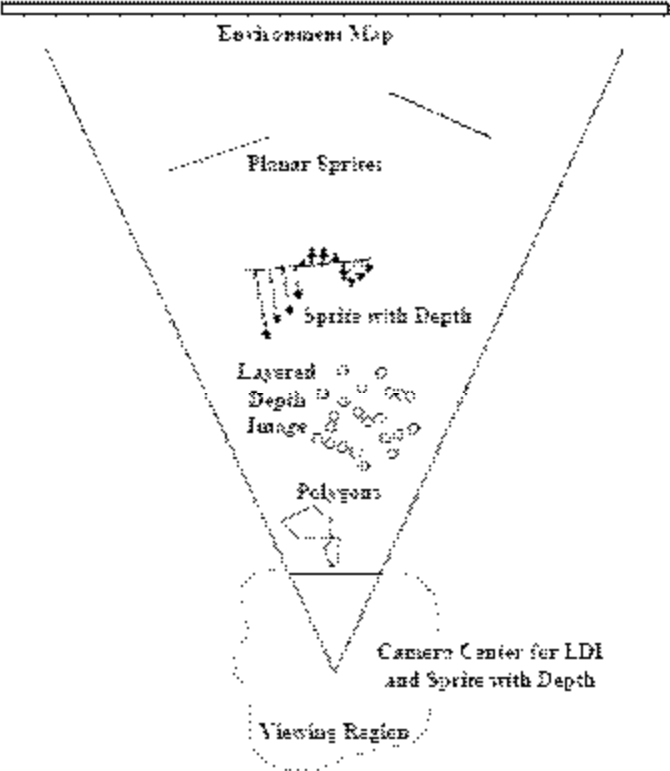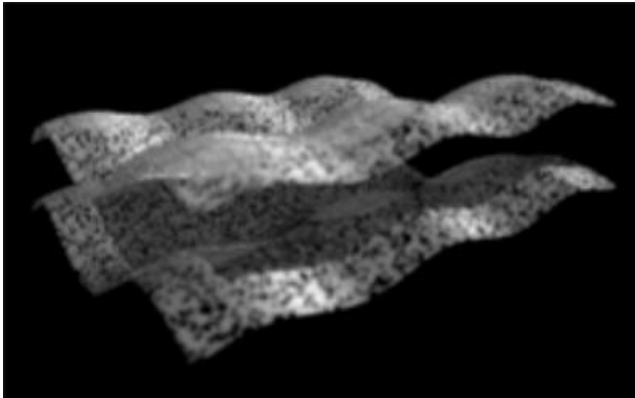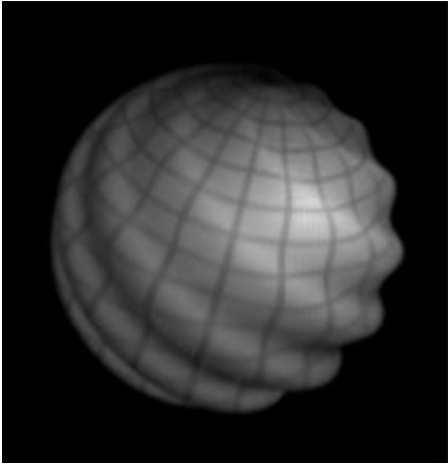
# Application of Image warpping

- Accelerate walkthrough of geometrically complex static scenes

- Show an environment in far distance.

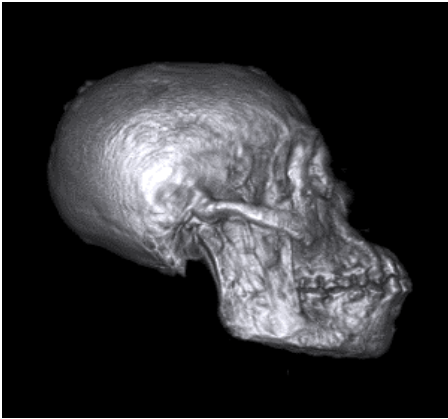- Re-render a scene from nearby view points.

# Point based rendering

- Marc Levoy
  - "The Use of Points as a Display Primitive"
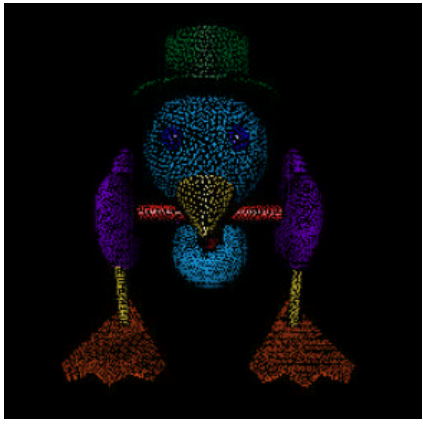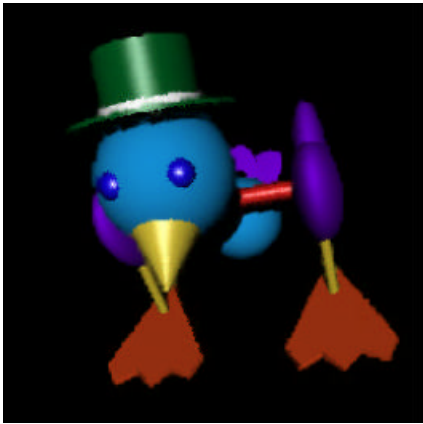


  - "Display of Surfaces from Volume Data"

# Point sampling rendering

- J.P. Grossman
  - "Point Sample Rendering"
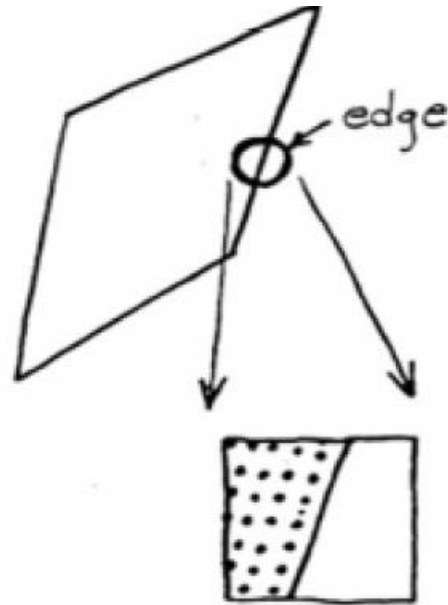
**Point based rendering**

- Converts objects to points


- Filter
- Normalization
- Texture mapping


- Renders those points

## Point based rendering

- Application
  - Medical Image Processing

- Some movie for Point based rendering
  - Skull – 1
  - Skull - 2

- Render with depth information

- L.McMillan.
  - "The Delta Tree: An Object-Centered Approach to Image-Based Rendering."
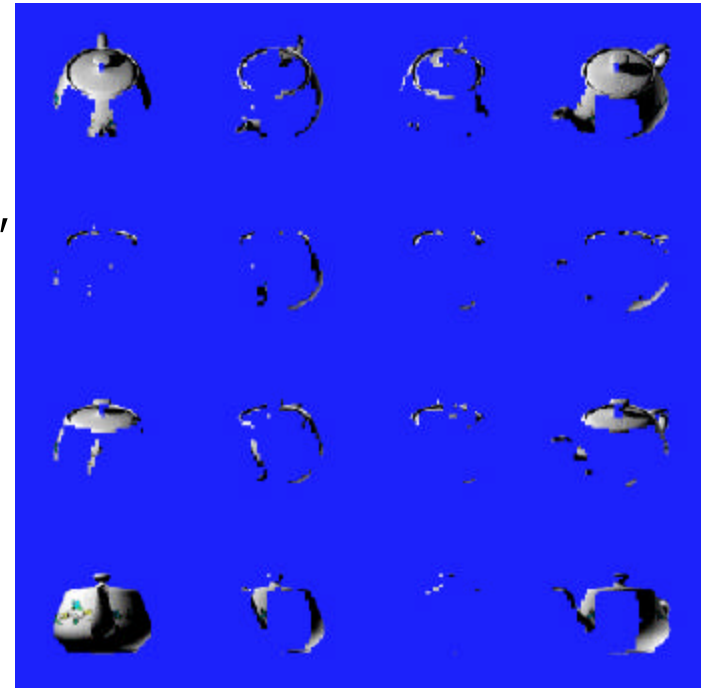
- D. Lischinski and A. Rappoport.
  - "Image-Based Rendering for Non-Diffuse Synthetic Scenes."
    - Coverage is considered by the depth information.
    - The shade will not change even when the view is moving.
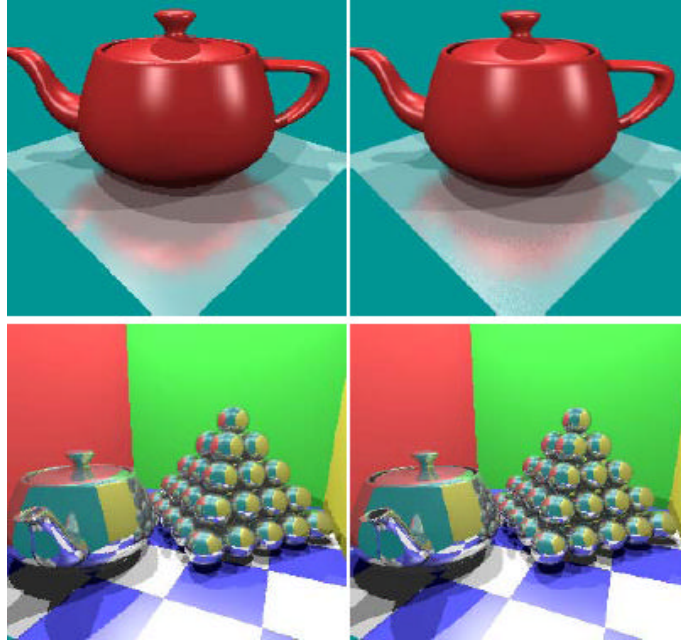
# Point based rendering

- Use points as a display primitive
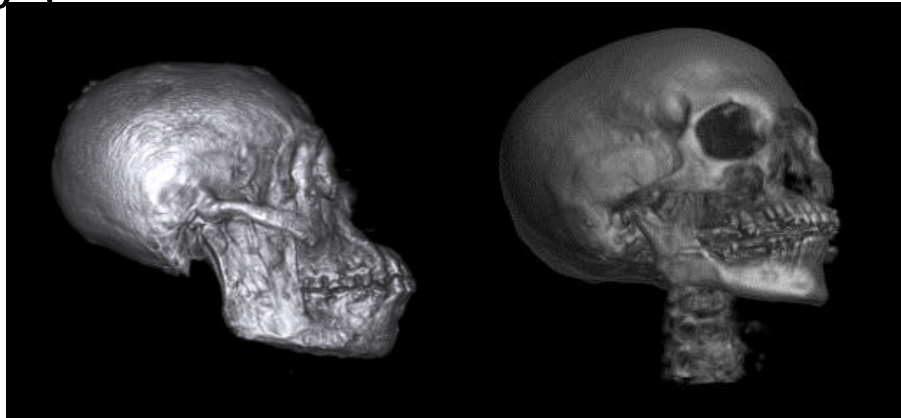


- Object rendered
  with box reconstruction
  filter

# Image based modeling

- Yizhou Yu
  - "IMAGE-BASED MODELING AND RENDERING OF ARCHITECTURE WITH INTERACTIVE PHOTOGRAMMETRY AND VIEW-DEPENDENT TEXTURE MAPPING"

# Image based modeling

- Get the image for the target



- Registration
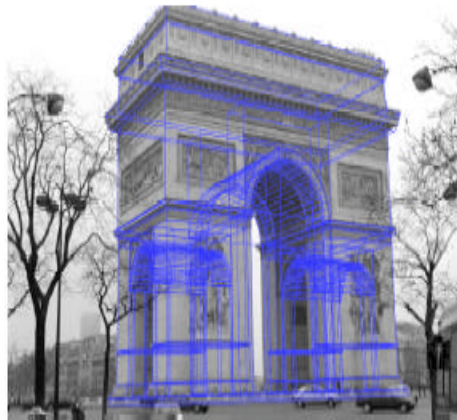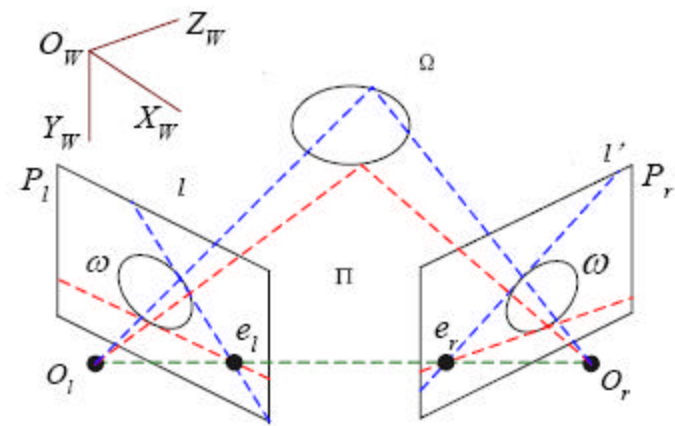- Camera parameter decision

# Image based modeling

- Reconstruction



- Texture



- Efficiency – very slow

## Image based Rendering

- Plenoptic modeling
  - Adelson and Bergen, "The Plenoptic Function and Elements of Early Vision."

- Light field rendering and Lumigraph -- 1996
  - Marc Levoy and Pat Hanrahan, "Light Field Rendering"
  - Michael F. Cohen, "The Lumigraph"

- BRDF rendering

# Image based Rendering

- Rendering without polygens
- No depth information
- Phong model
  - $I_{tot} = I_{amb} + I_{diff} + I_{spec}$
  - $I_{diff} = (N * L) = $ Light Engergy $ * \cos(?)$

- Represent the $I_{diff}$
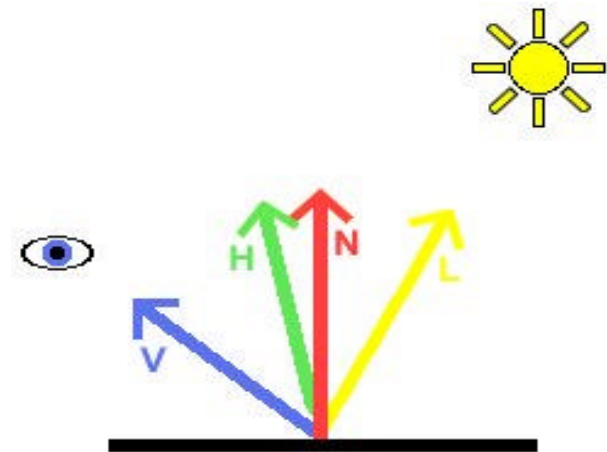  - $I_{tot} = f(?, ?, ?, V_x, V_y, V_z, time)$

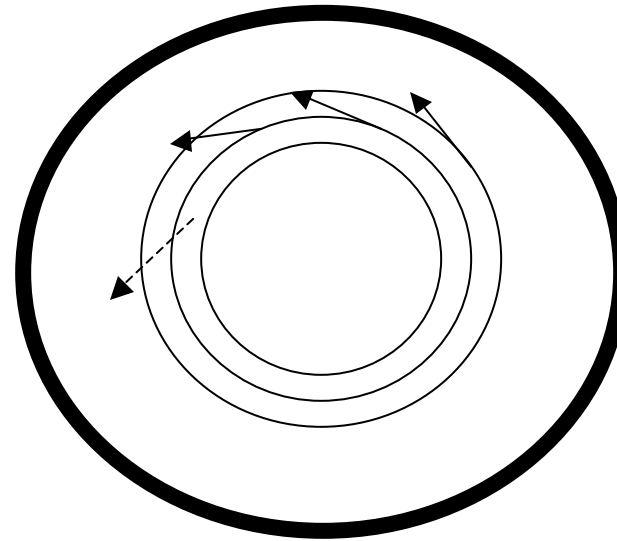# Image based Rendering

- Panorama
  - Model Simplification
    - $I_{tot} = f (V_x, V_y, V_z)$

- Movie-map system
- QuickTimeVR system
- Plenoptic modeling system
  - McMillan and Bishop, "Plenoptic Modeling: An Image-Based Rendering System."

# Plenoptic modeling

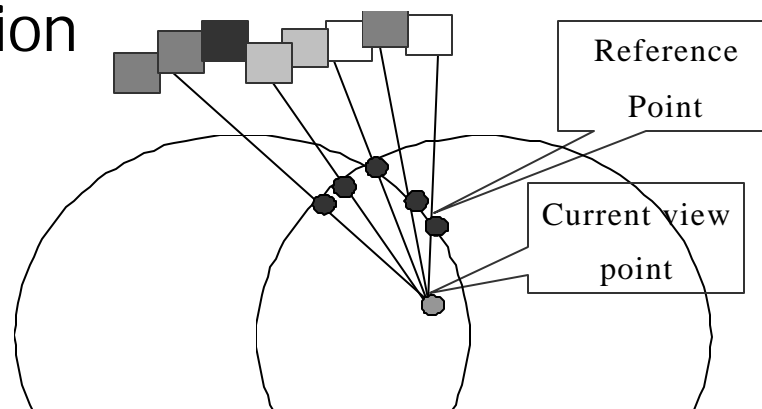- Concentric Panorama
  - Images acquisition



  - Registration

# Ray tracing for warpping

- Image warpping



- New view image creation

- Filtering



Reference Point

Current view point

- The plenoptic modeling system

- Lighting model
  - $I_{tot} = f\ (?\ ,\ ?\ ,\ ?\ ,\ V_x,\ V_y,\ V_z,\ time)$

- Simplification
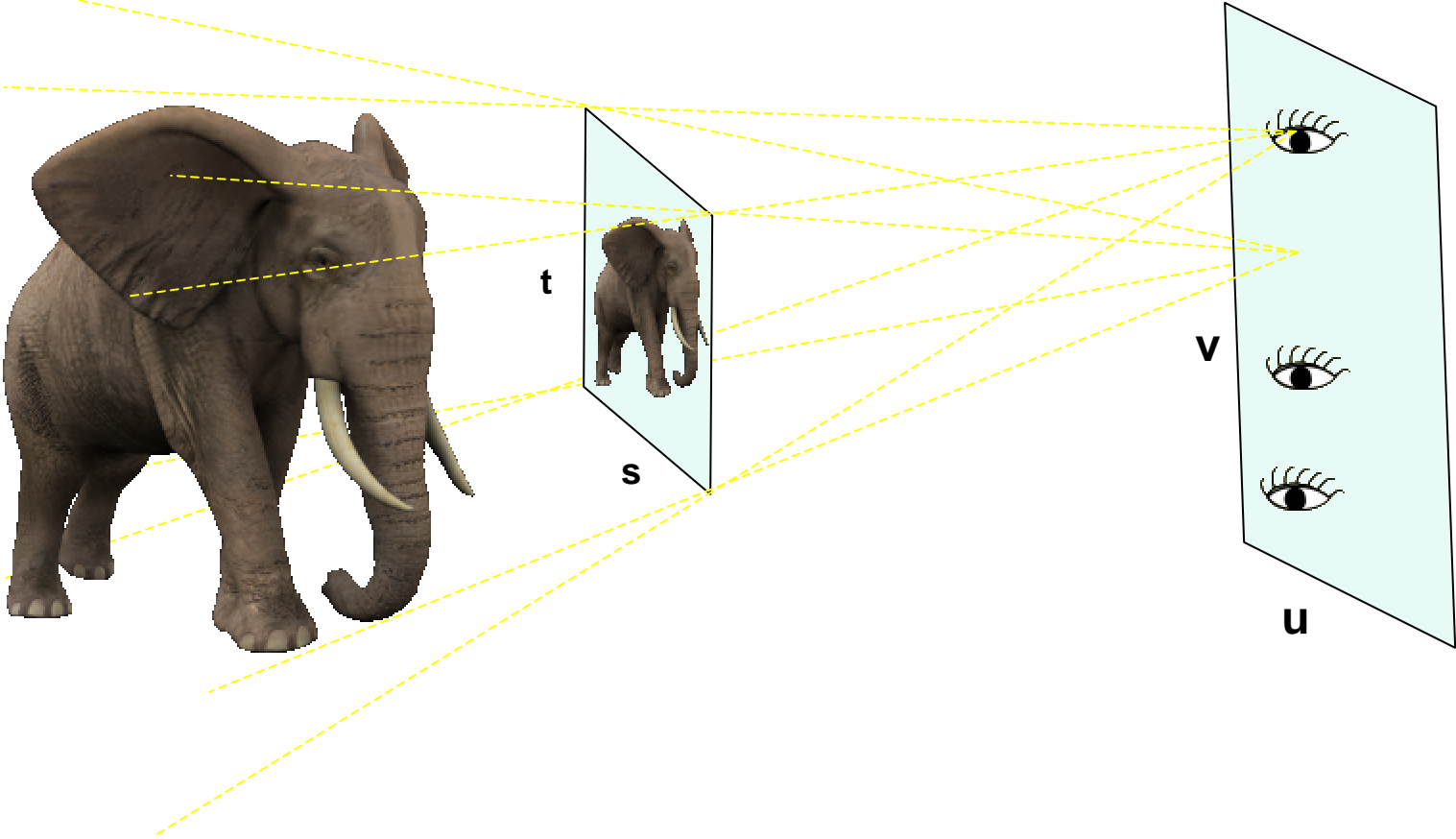  - $I_{tot} = f\ (?\ ,\ ?\ ,\ V_x,\ V_y)$
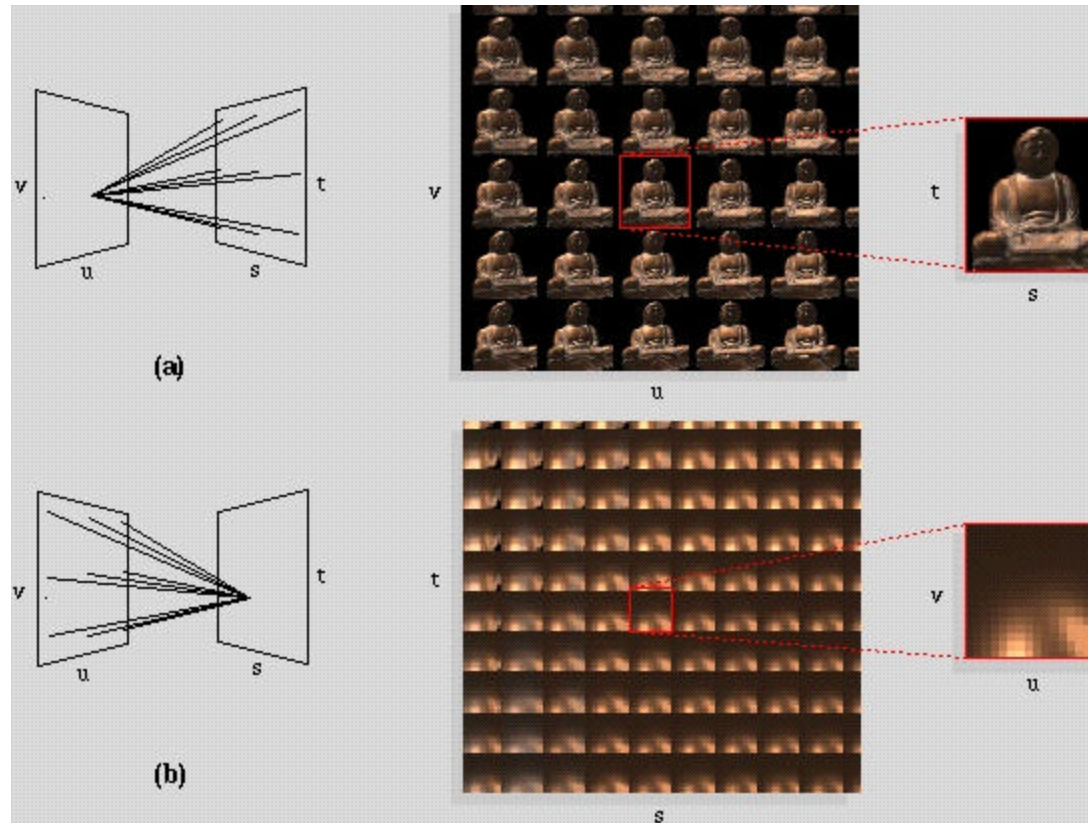  - $I_{tot} = f\ (u,\ v,\ x,\ y)$
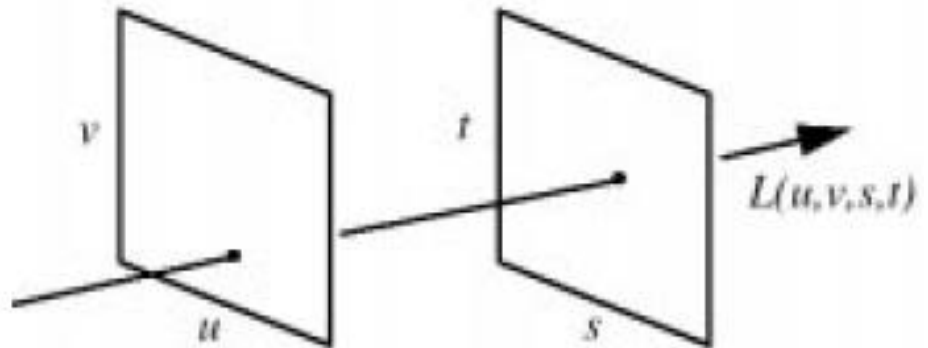
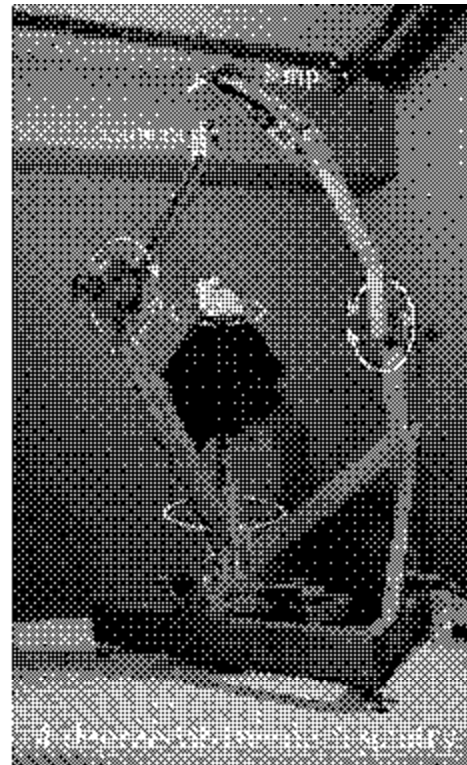# Light field rendering

- Representation

# Light field rendering
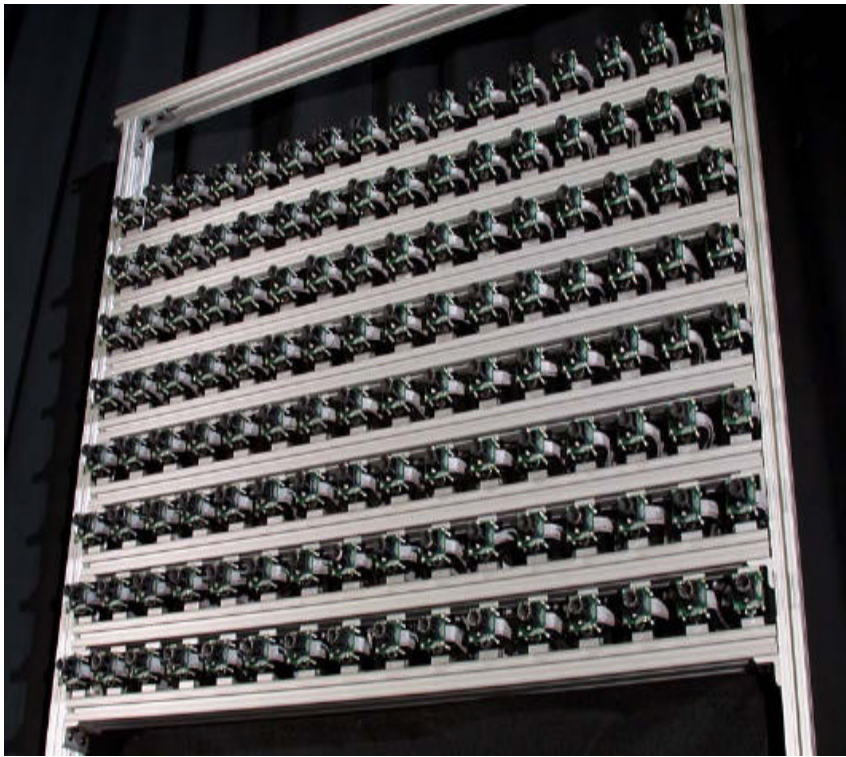
- Image sampling

# Light field rendering

- Some equipments for the data sampling

# Light field rendering

input light field → **Registration** → registered light field

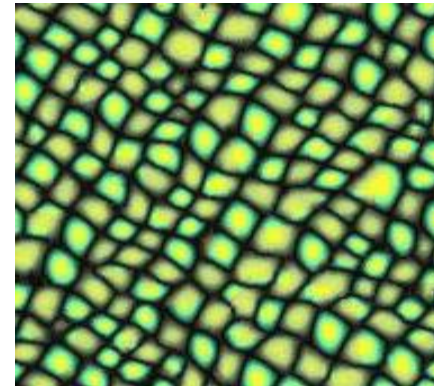**Median** → median image → **Texture Synthesis** → output light field
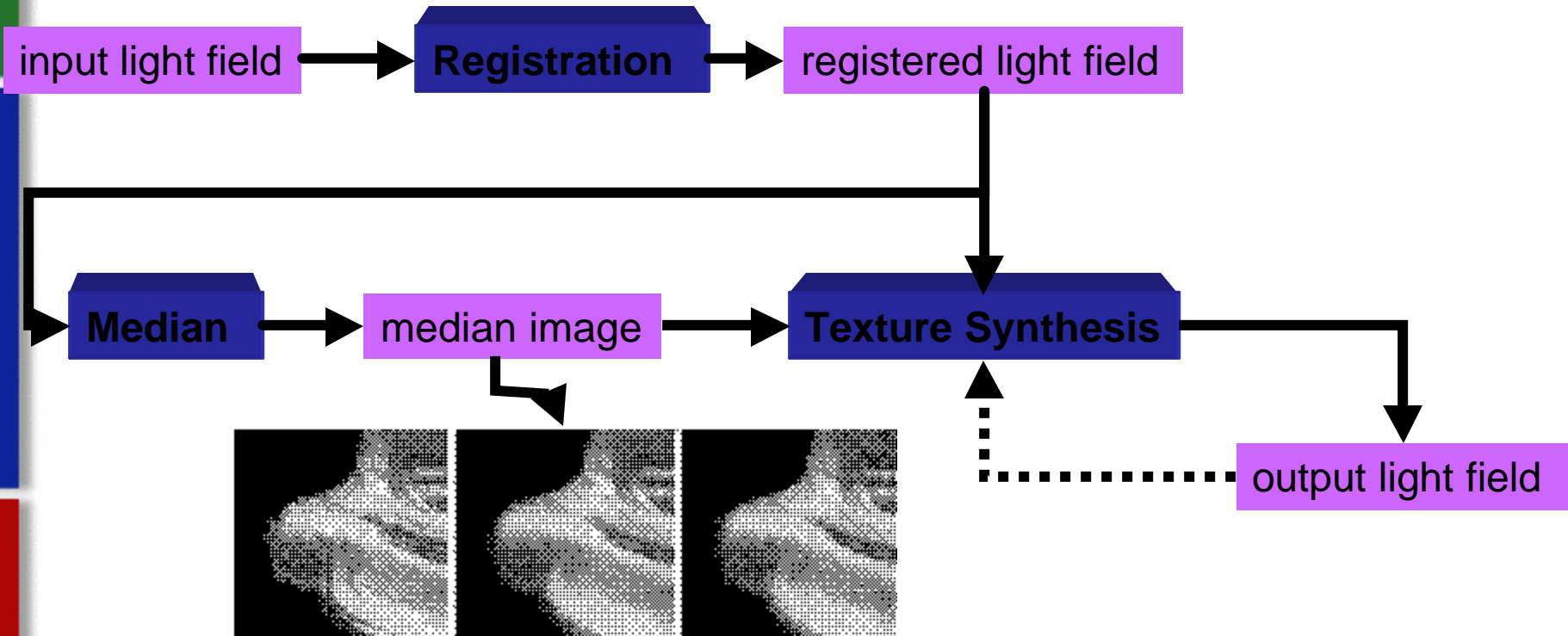
## Light field rendering
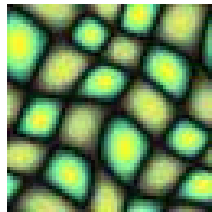
- Ray tracing and create a new image
- Filter the image to make it smooth
- Texture
- The procedure and Some of common results

# Light field rendering

- Texture synthesis
  - Li-Yi Wei, Marc Levoy, "Texture Analysis and Synthesis"

- Texture synthesis
  - Extension of the priority based texture synthesis to 4D.
  - Set the initial condition to be estimated data given from the median image.
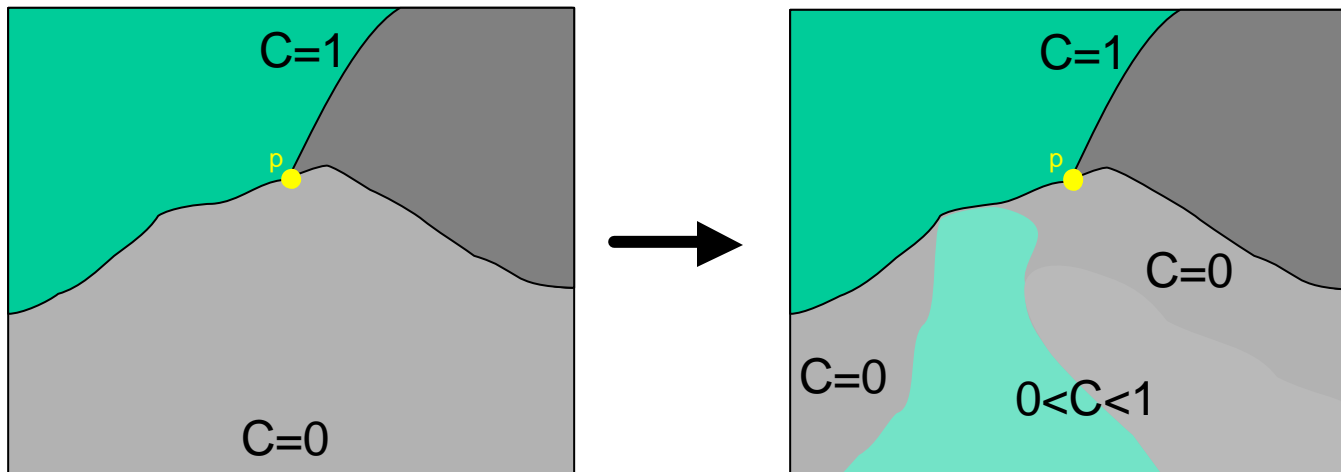
# Light field rendering

- Power of the light field – 1 **Removing the pillars**

# Light field rendering

- Power of the light field – 2 **Removing the fence**

- 5-D lighting modeling is created
  - $I_{tot} = f(u, v, x, y) + $ light energy

- BRDF is presented
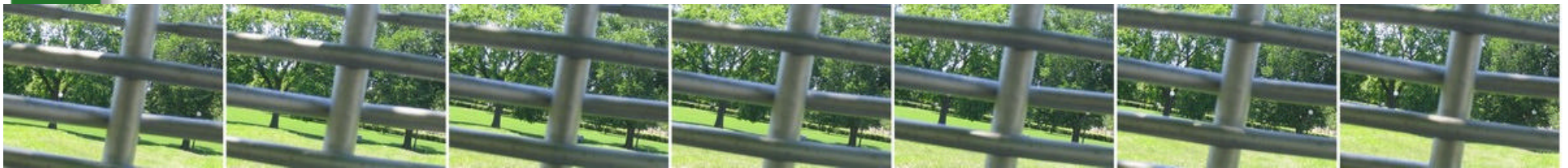  - A sample for BRDF



Minnaert Reflections
Showing Velvet Fabric

Normal Shading

# Refercence

- **1.** Marc Levoy and Pat Hanrahan, Light Field Rendering , *Proc. SIGGRAPH 1996*

- **2.** Marc Levoy, Display of Surfaces from Volume Data, *IEEE Computer Graphics and Applications, Vol. 8, No. 3, May, 1988*

- **3.** S. J. Gortler, R. Grzeszczuk, R. Szeliski, and M. F. Cohen. "The Lumigraph." In H. Rushmeier, editor, *SIGGRAPH 96 Conference Proceedings*, Annual Conference Series, pages 43–54. ACM SIGGRAPH, Addison Wesley, August 1996. held in New Orleans, Louisiana, 04-09 August 1996.

- **4.** Tomas Moller, Eric haines, "Real time rendering"

- **5.** D. Lischinski and A. Rappoport. "Image-Based Rendering for Non-Diffuse Synthetic Scenes." In G. Drettakis and N. Max, editors, *Eurographics Workshop on Rendering 1998*, pages 301–314. Eurographics, Springer Wien, 1998. held in New Orleans, Louisiana, 04-09 August 1996.

- **6.** G. Schaufler. "Per-Object Image Warping with Layered Impostors." In N. M. G. Drettakis, editor, *Rendering Techniques '98, Proceedings of the Eurographics Workshop in Vienna, Austria, June 29-July 1, 1998*, pages 145–156. Eurographics, Springer, July 1998.

# The End.

[Thank you!](#)

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