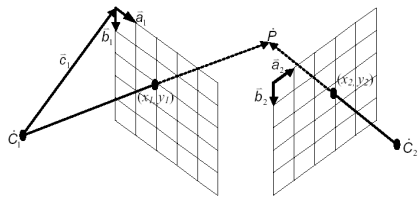
Layered Depth Images

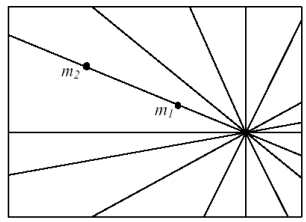
Today's Short Film

3D Home Video Scene in movie "Minority Report"

3D Warping

- Today's Handout:
  - Derivation of the 3D warping equation.
  - Explanation of the "Occlusion Compatible Order"





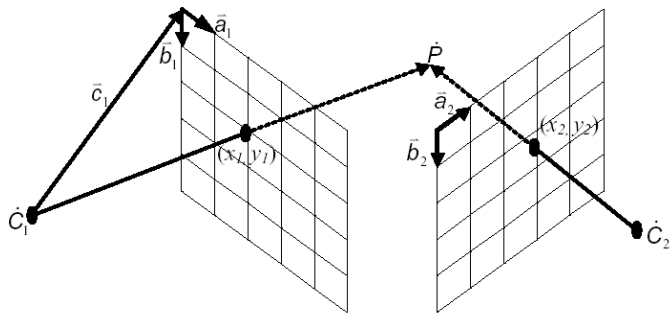
3D Image Warping (Review)

- Each pixel in the source images has coordinates (u_1, v_1), depth info δ_1, and color.
- Warping Equation is applied to each pixel

$$(u_2, v_2) = f(u_1, v_1, \delta_1)$$

$$= \left(\frac{a \times u_1 + b \times v_1 + c + d \times \delta_1}{i \times u_1 + j \times v_1 + k + l \times \delta_1} , \frac{e \times u_1 + f \times v_1 + g + h \times \delta_1}{i \times u_1 + j \times v_1 + k + l \times \delta_1} \right)$$

- How are the variables *a* to *l* calculated?



$$\dot{P} = \dot{C} + (\vec{a}x + \vec{b}y + \vec{c}) / \delta$$

$$\dot{P} = \dot{C}_1 + \begin{bmatrix} a_{1x} & b_{1x} & c_{1x} \\ a_{1y} & b_{1y} & c_{1y} \\ a_{1z} & b_{1z} & c_{1z} \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} \frac{1}{\delta_1} = \dot{C}_2 + \begin{bmatrix} a_{2x} & b_{2x} & c_{2x} \\ a_{2y} & b_{2y} & c_{2y} \\ a_{2z} & b_{2z} & c_{2z} \end{bmatrix} \begin{bmatrix} x_2 \\ y_2 \\ 1 \end{bmatrix} \frac{1}{\delta_2}$$

Occlusion Compatible Order

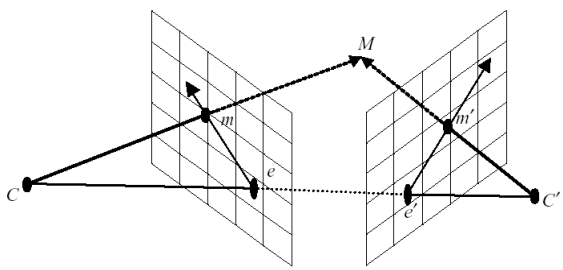
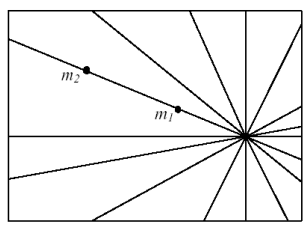
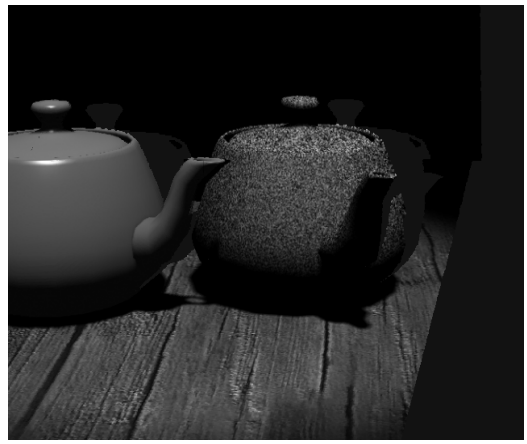


Figure B-1: The epipolar geometry between two images.



Artifacts of 3D Warping

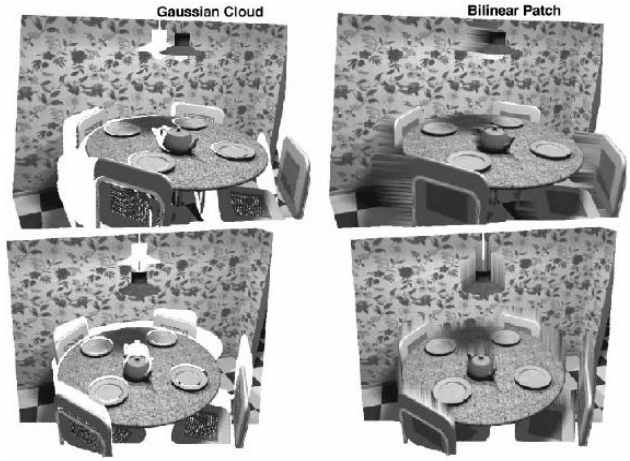
- Due to incorrect reconstruction.
- Due to occlusion (or visibility).



Reconstruction

- Solving it by meshing?
  - Must know the connectivity between points.
- Solving it by splatting?
  - Size determined by viewing distance.
  - Shape determined by surface normal.
  - References: LDI [SG98], Surfel [SG2000], Surface Splatting [SG2001].

Meshing Artifacts



Picture source: Leonard McMillan

Occlusion/Visibility

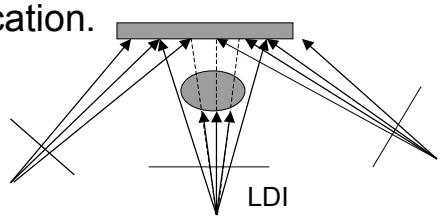
- Use more input images.
- Or use texture synthesis.

Using Multiple Depth Images

- Increasing rendering time.
- The occlusion-compatible order is only valid within an image.
  - Can be solved by the Layered Depth Image (LDI)

Layered Depth Image (LDI)

- Shade et. al. SIGGRAPH 98
  - Merge multiple source images.
  - Allow multiple pixels at the same pixel location.



LDI

- A simple extension of depth images:
  - Each pixel can now contain multiple layers (of color and depth).
- An LDI is built by combining multiple depth images:
  - First, warp all depth images to the same view.
  - Don't throw away the hidden pixels!

Occlusion Compatible Order in LDI

- The occlusion compatible order exists in LDI's.
  - The layers must be sorted first.
  - Because there is only one view (cammera) point, McMillan's occlusion compatible order still applies.