Image Formation (approximately)

- Vision infers world properties form images.
- So we need to understand how images depend on these properties.
- Two key elements
 - Geometry
 - Light
 - We consider only simple models of these





Used to observe eclipses (eg., Bacon, 1214-1294)By artists (eg., Vermeer).





http://brightbytes.com/cosite/collection2.html (Jack and Beverly Wilgus)









Vanishing points

- Each set of parallel lines meets at a different point
 - The vanishing point for this direction
- Sets of parallel lines on the same plane lead to *collinear* vanishing points.
 - The line is called the $\ensuremath{\textit{horizon}}$ for that plane

Properties of Projection

- · Points project to points
- Lines project to lines
- · Planes project to the whole image
- Angles are not preserved
- Degenerate cases
 - Line through focal point projects to a point.
 - Plane through focal point projects to line
 - Plane perpendicular to image plane
 - projects to part of the image (with horizon).



Take out paper and pencil









The Equation of Weak Perspective

$$(x, y, z) \rightarrow s(x, y)$$

• s is constant for all points.

• Parallel lines no longer converge, they remain parallel.

Pros and Cons of These Models

- Weak perspective much simpler math.
 Accurate when object is small and distant.
 Most useful for recognition.
- Pinhole perspective much more accurate for scenes.
 - Used in structure from motion.
- When accuracy really matters, must model real cameras.













Basic fact: Light is linear

- Double intensity of sources, double photons reaching eye.
- Turn on two lights, and photons reaching eye are same as sum of number when each light is on separately.

Modeling How Surfaces Reflect Light

- First, language for describing light Striking a surface;
 - Leaving a surface.
- Next, how do we model the relationship between the two.
 - This depends on the material;
 - Eg., cloth or mirror.





















(http://graphics.cs.ucdavis.edu/GraphicsNotes/Shading/Shading.html)

Modeling Light Sources

- Light strikes a surface from every direction in front of the object.
- Light in a scene can be complex:













- Assume each surface normal receives equal light from all directions.
- $i = a\lambda$
- Diffuse lighting, no cast shadows.
- Ambient + point source turns out to be good approximation to next model.





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