ISTA 352

Lecture 10

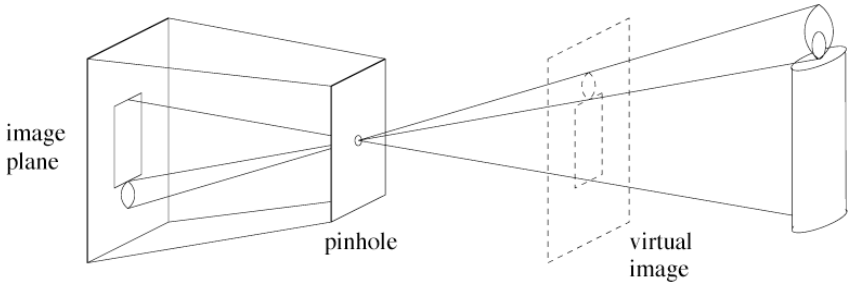
The world in perspective

Administrivia

- Next time I will be assuming the linear algebra developed so far
  - Please review it!

Pinhole cameras

- Abstract camera model--box with a small hole in it
- Pinhole cameras work for deriving algorithms--a real camera needs a lens



Distant objects are smaller

Slide courtesy
Frank Dellaert

Object size vs. object depth

(Images copyright John H. Kranz, 1999)

Size Constancy

Slide courtesy
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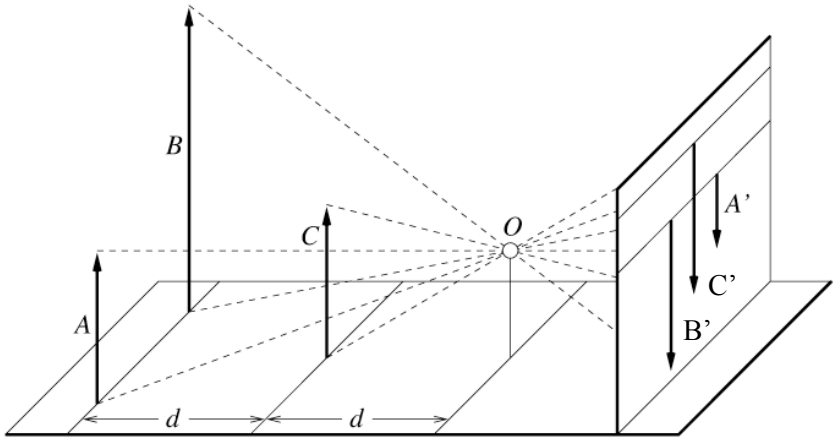


Geometric properties of projection

- Points go to points
- Lines go to lines
- Polygons go to polygons
- Degenerate cases
  - line through focal point projects to a point
  - plane through focal point projects to a line

Vanishing points

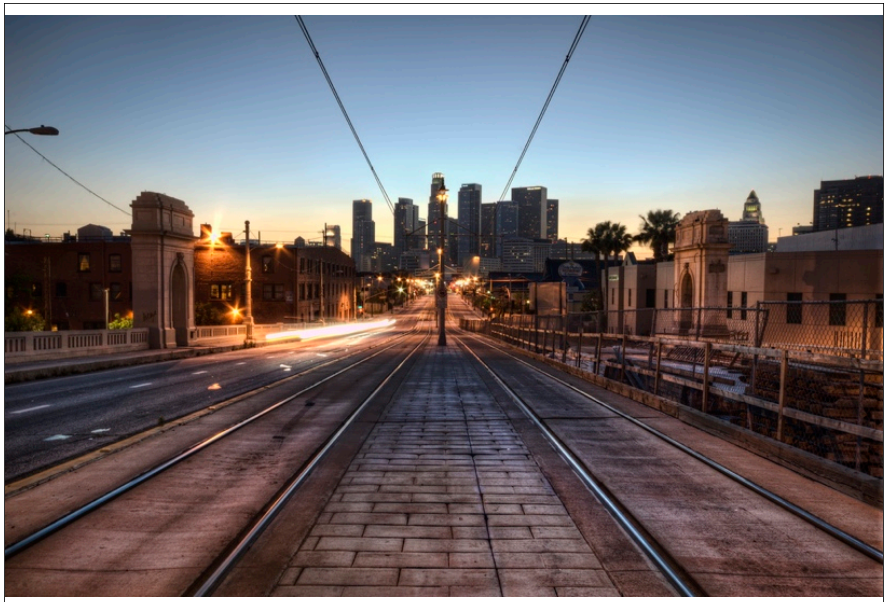


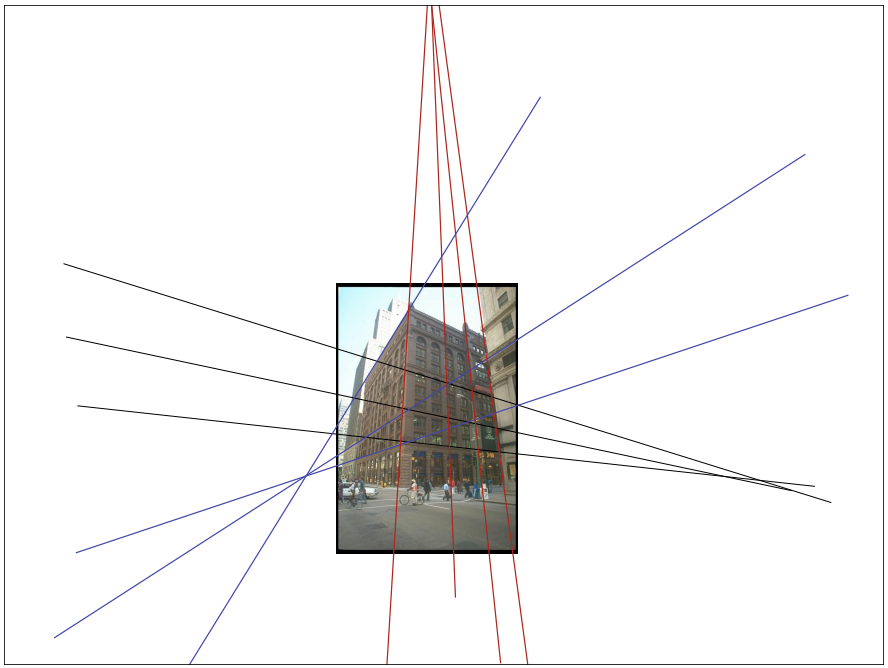
Photo by Neil Kremer

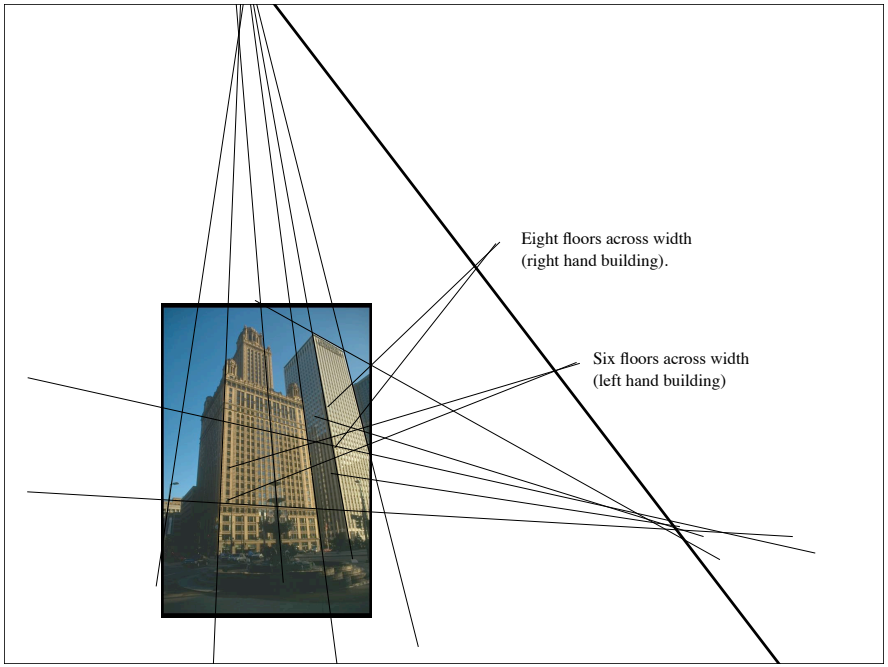
Vanishing points

- Each set of parallel lines (=direction) meets at a different point
  - The *vanishing point* for this direction
  - Exception is lines that are perpendicular to the camera plane

Vanishing points

- Each set of parallel lines (=direction) meets at a different point
  - The *vanishing point* for this direction
  - Exception is lines that are perpendicular to the camera plane
- The vanishing points for directions **on a plane** are co-linear
  - The horizon for that plane

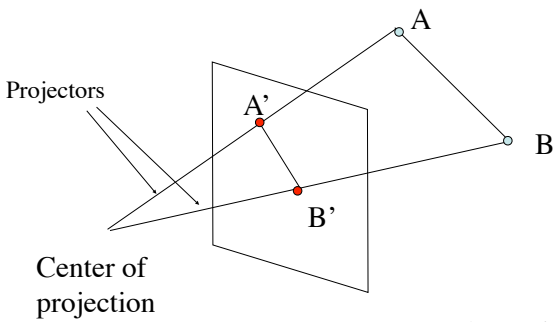




Is the picture a fake?

- If scale and perspective don't work correctly, perhaps the image is a fake!
- We can check if:
  - Each set of parallel lines (=direction) meets at a different point
  - Sets of parallel lines on the same plane lead to *collinear* vanishing points.

More on projections



The projection of A is A'

What is the projection of A'?

More on projections

- Want to think about geometric image formation as a mathematical transformation taking points in the 3D world and mapping them into an image plane.
- Mathematical definition of a projection: PP=P
  - (Doing it a second time has no effect).
- Transformation looses information (e.g., depth)
  - Given a 2D image, there are many possible 3D worlds
  - Projections are not invertible!
    - Exception is P=I

Geometric Camera Model

- Let **P**=(X,Y,Z) be a point in space.
- Let (u,v) be image coordinates.
- A geometric camera model, G, tells us where P goes in the image.
- (u,v) = G(**P**)

World and camera coordinates