CSCI 497P/597P: Computer Vision

Lecture 18

Pinhole Camera Model

360 (Spherical) Panoramas

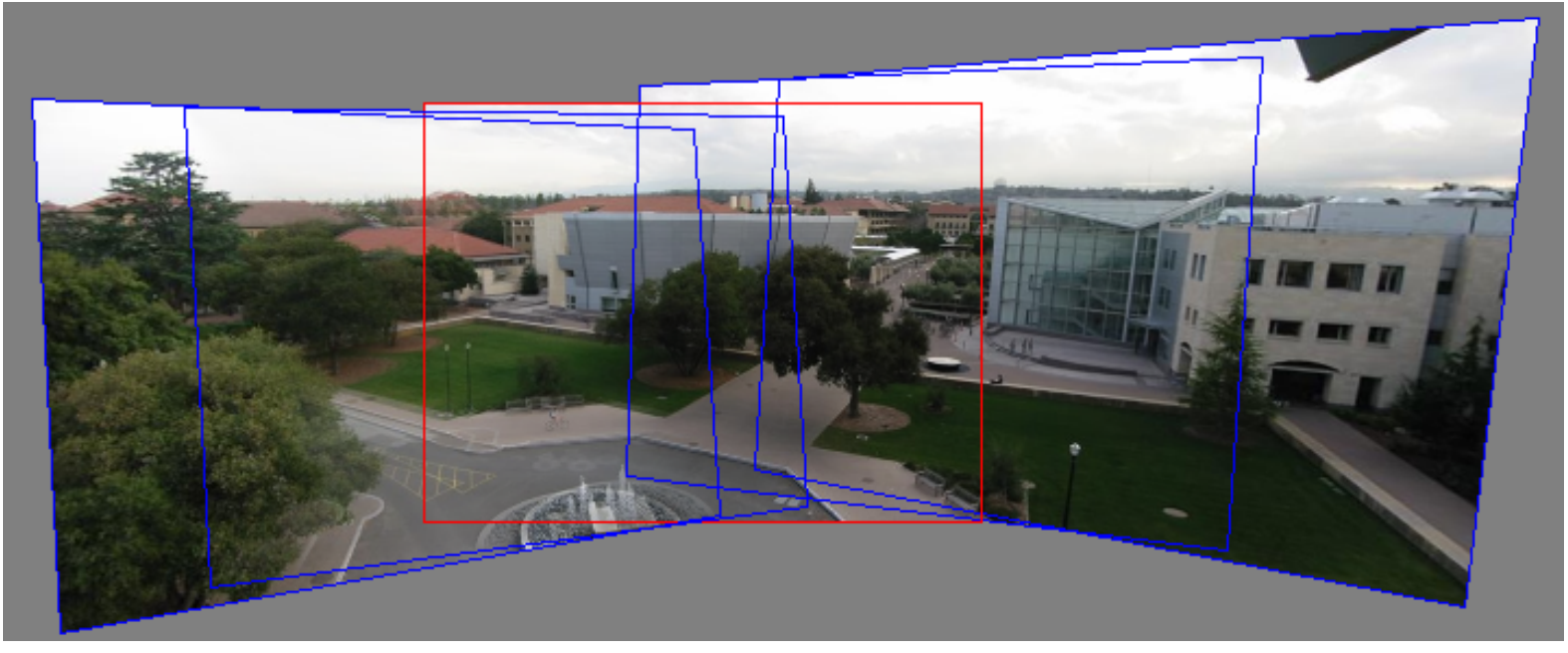
Announcements

- Deadline to pair up for P2 is Wednesday night.
  - Include your github usernames in your email.
- Reminder/597 update: Letter grade surveys
  - 497: opt in for letter grade by June 5
  - 597 opt in for P/NP by May 22

Goals

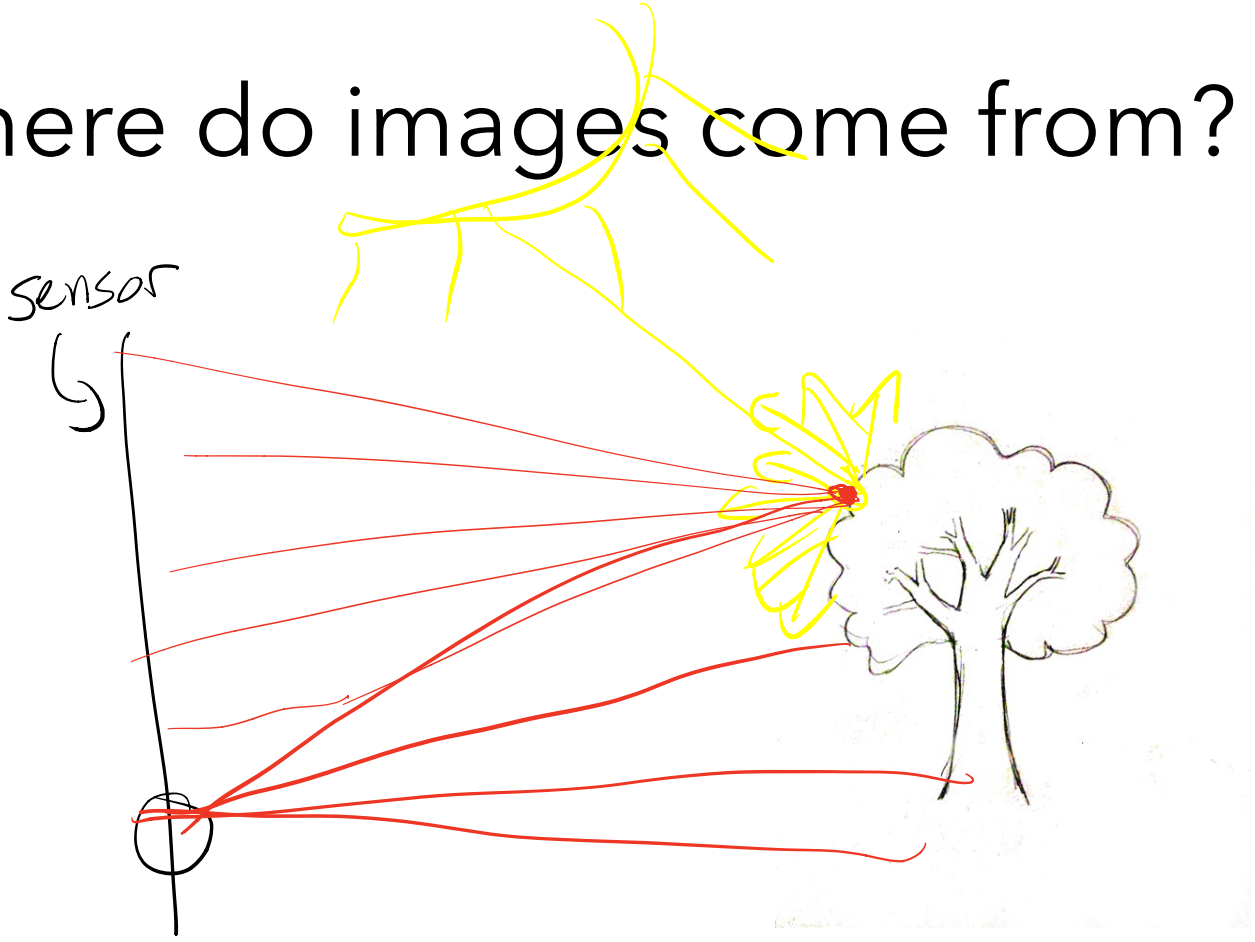
- Understand where images come from (under the pinhole camera model)
  - Be able to derive the 3x4 pinhole projection matrix
  - Understand the interpretation of planar panorama stitching in terms of using homographies to map images onto a common plane.
- Know how to create 360 degree panoramas by mapping images onto a spherical surface instead.

Can we make 360 panoramas?

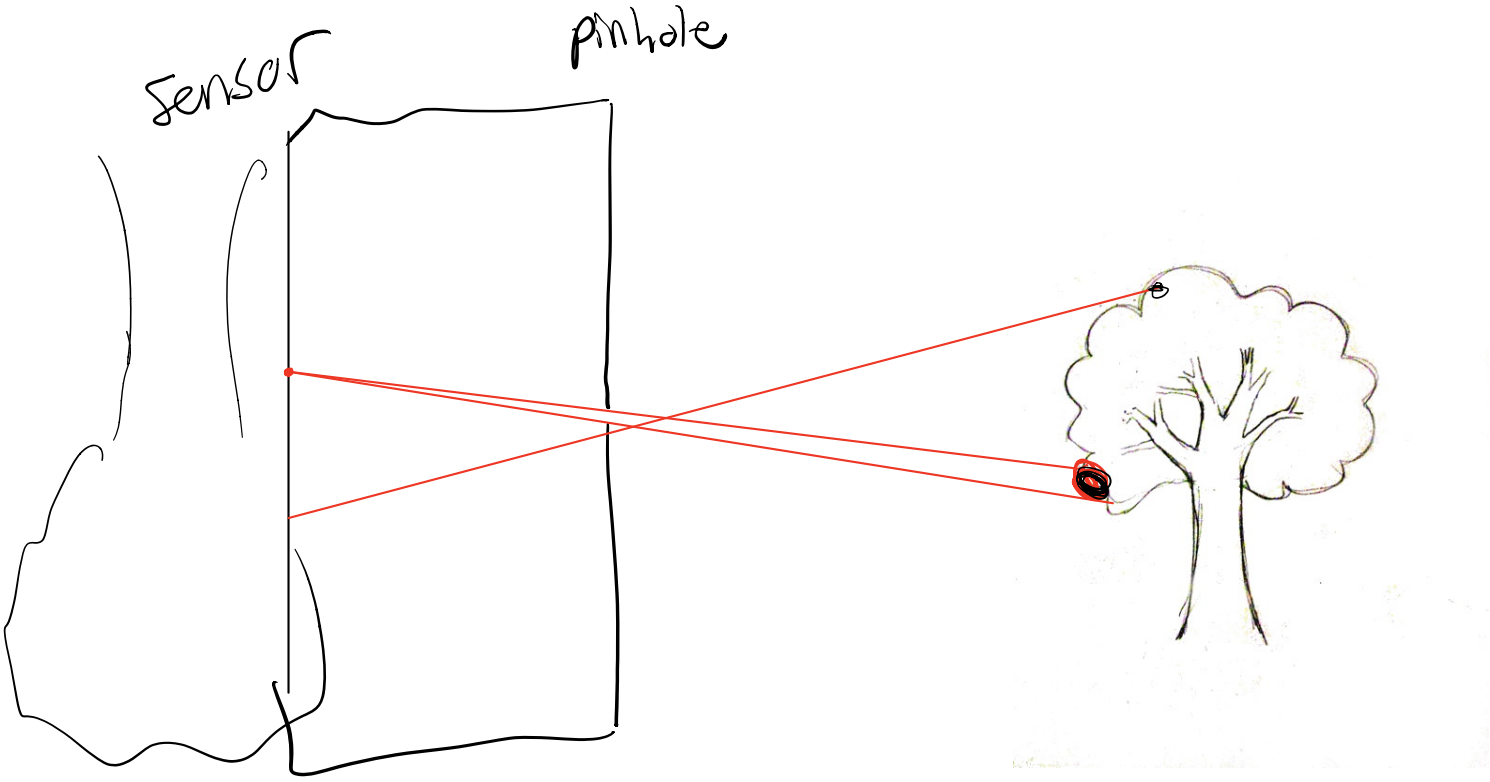


To answer this, we need to know how these images came to be.
Why can we even make **any** panoramas with homographies?

Where do images come from?



497Cam, Mk I



497Cam, Mk II

Camera Obscura (pinhole camera)

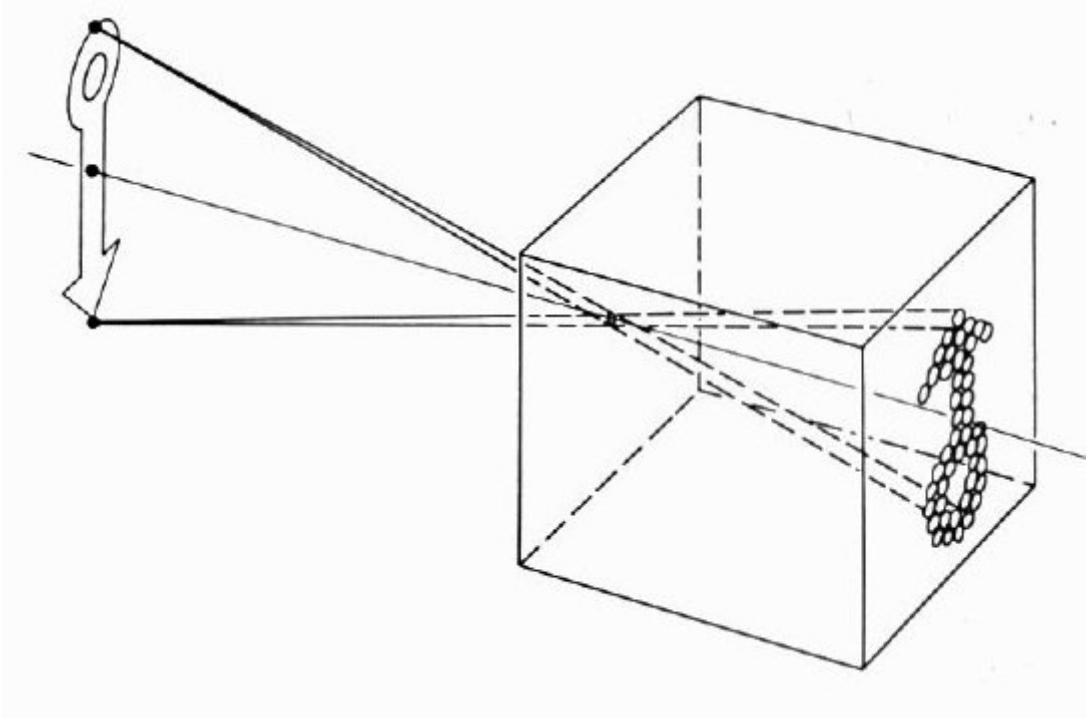
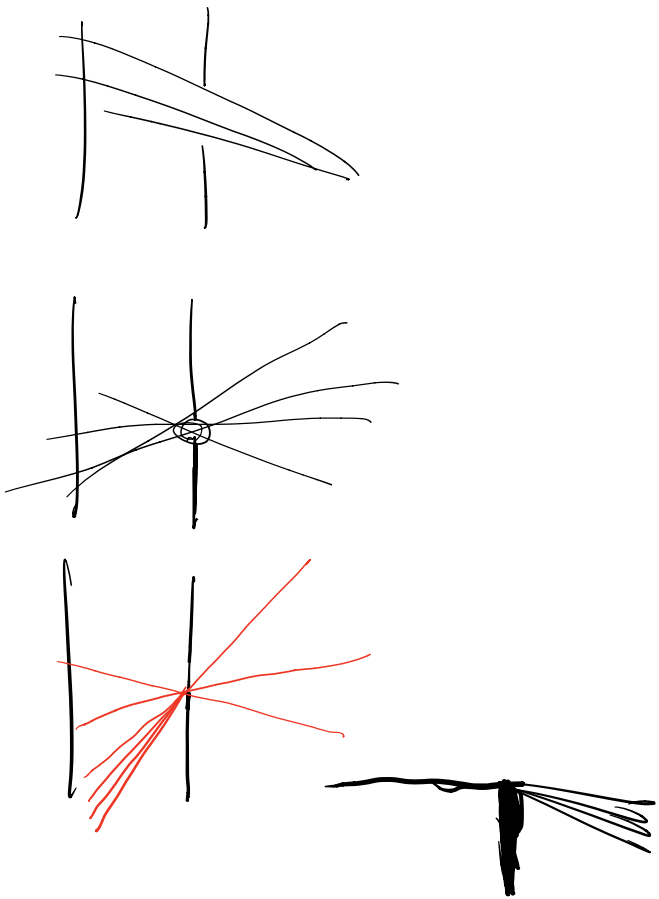
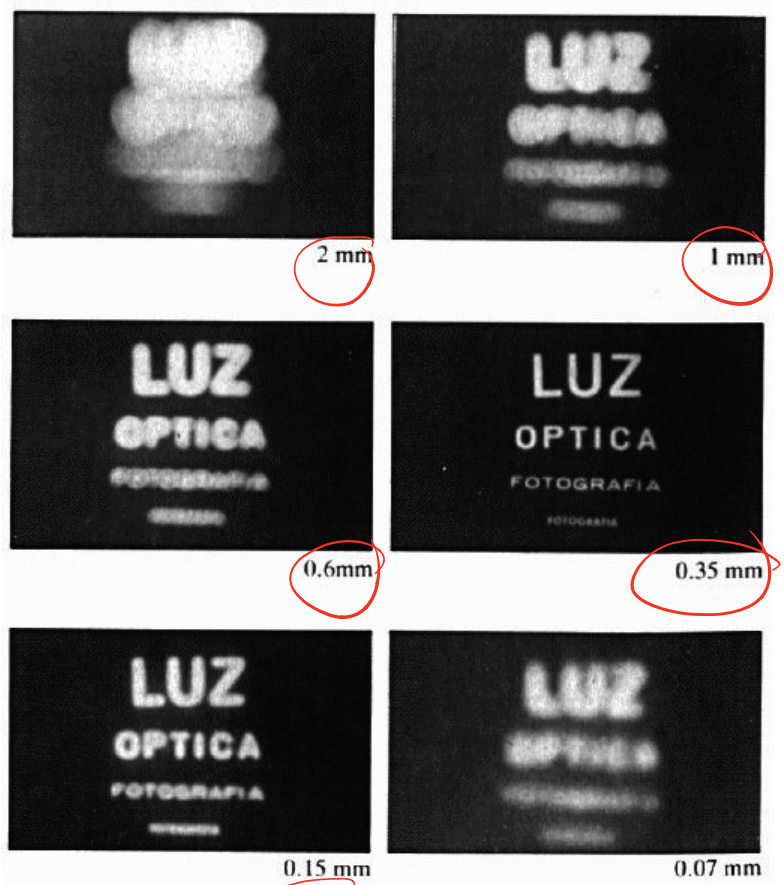


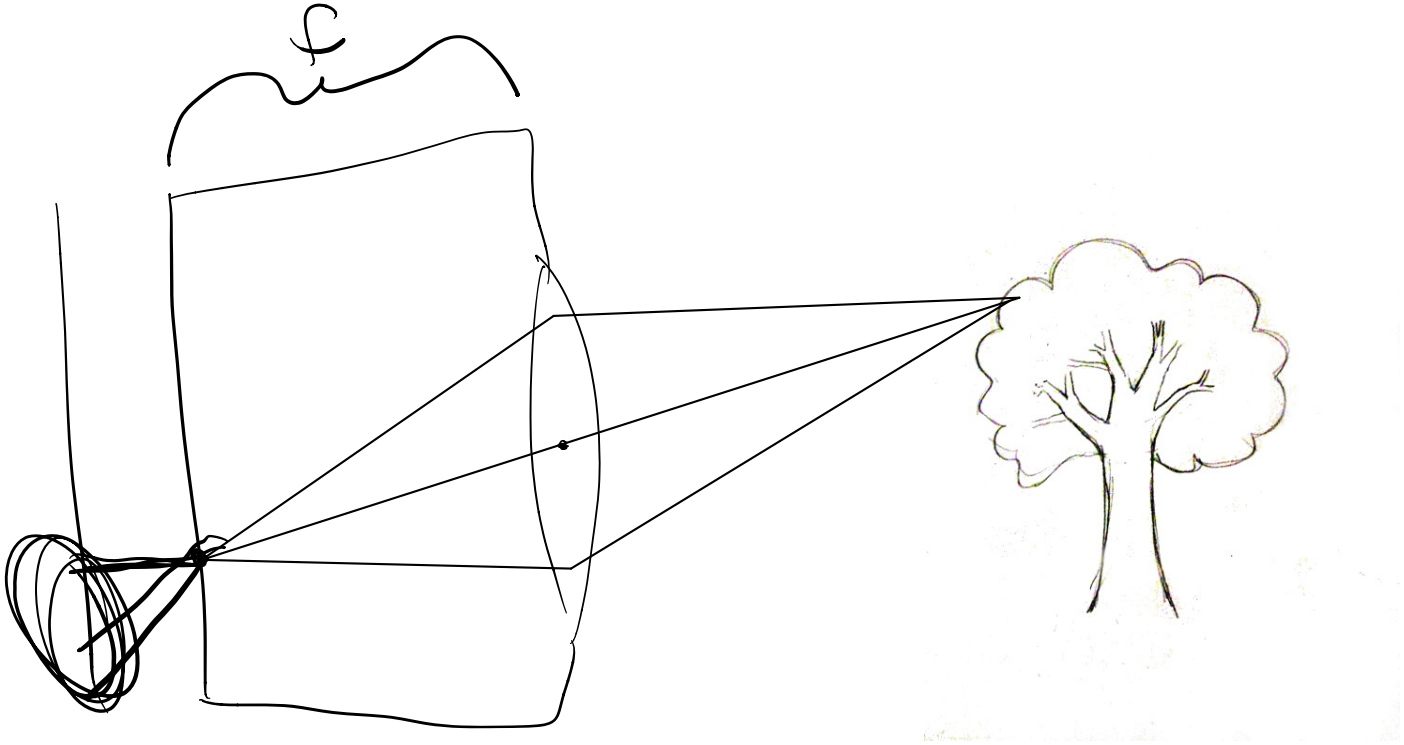
image: https://petapixel.com/2014/05/12/diy-tutorial-convert-room-camera-obscura/

The Effect of Pinhole Size





Aside: What about Lenses?



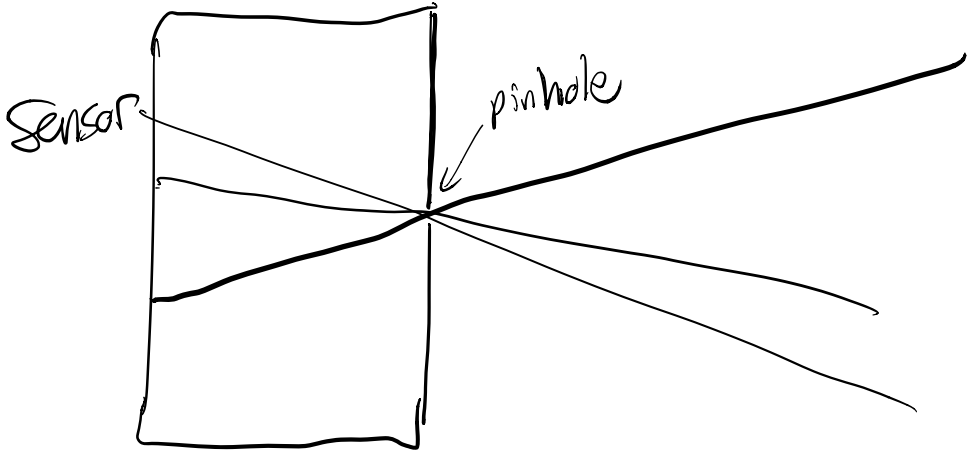
497Cam, Mk III


MAKE POVERTY HISTORY
JULIAN BEEVER
CoolOpticalIllusions.com

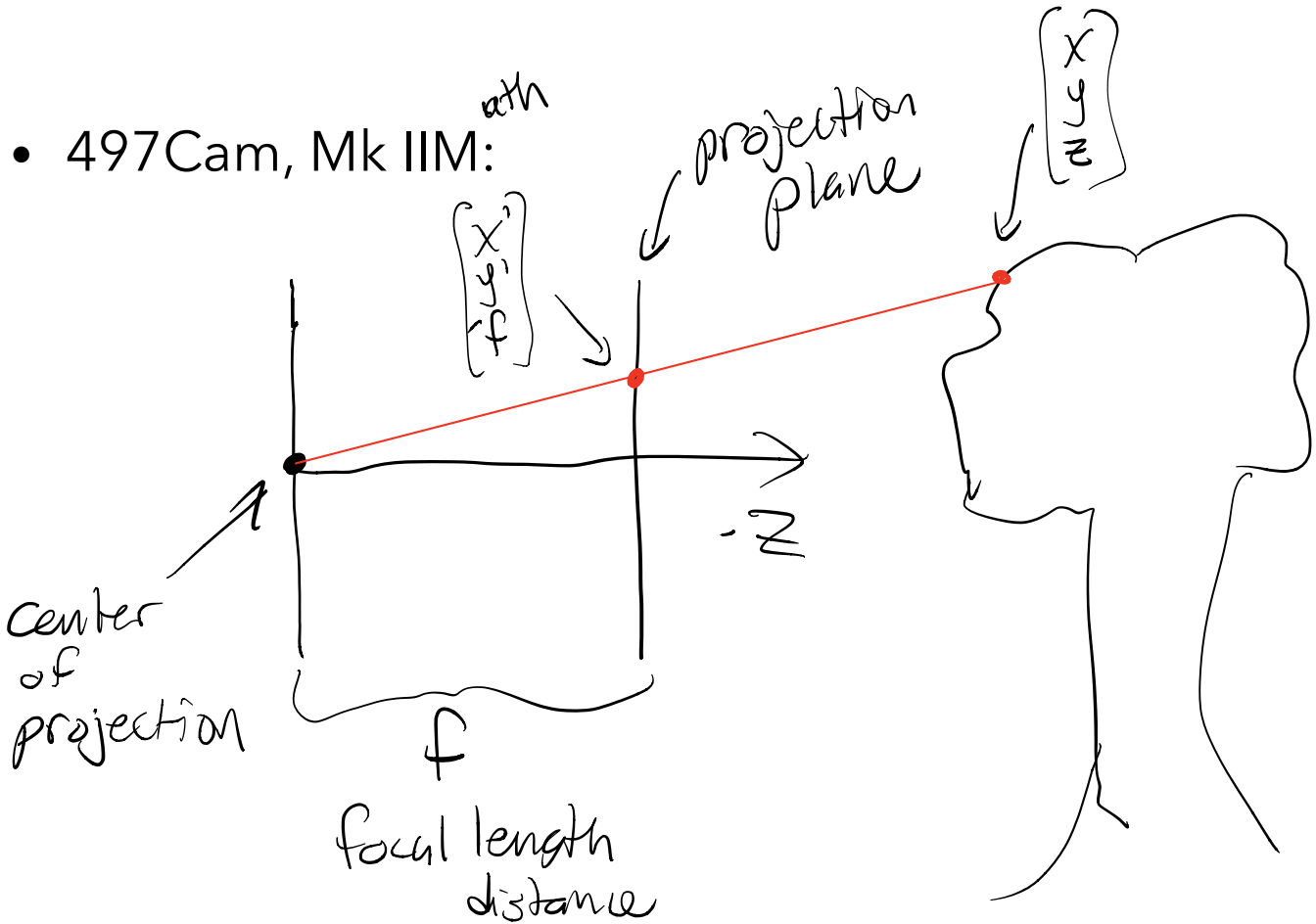

CoolOpticalIllusions.com

The Pinhole Camera Model

- 497Cam, Mk II:

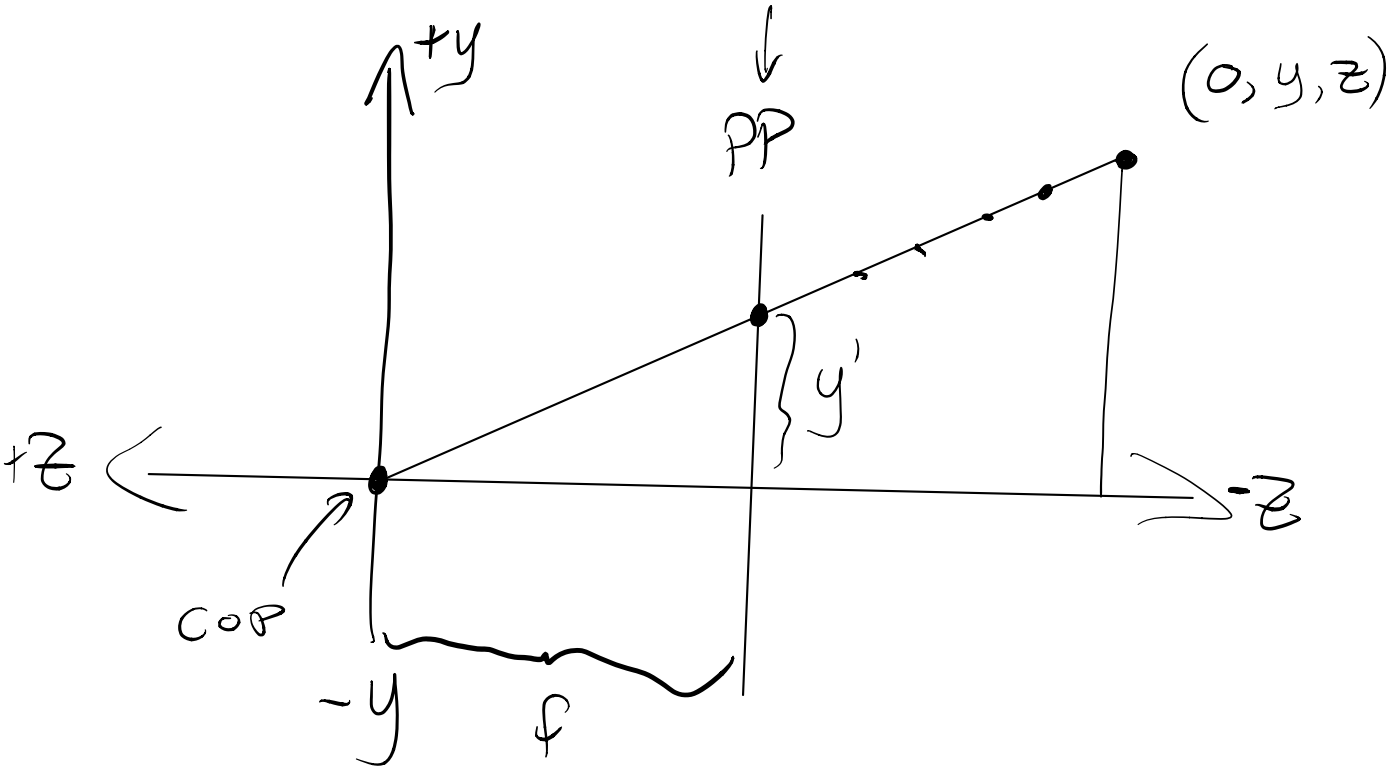


- 497Cam, Mk IIM:



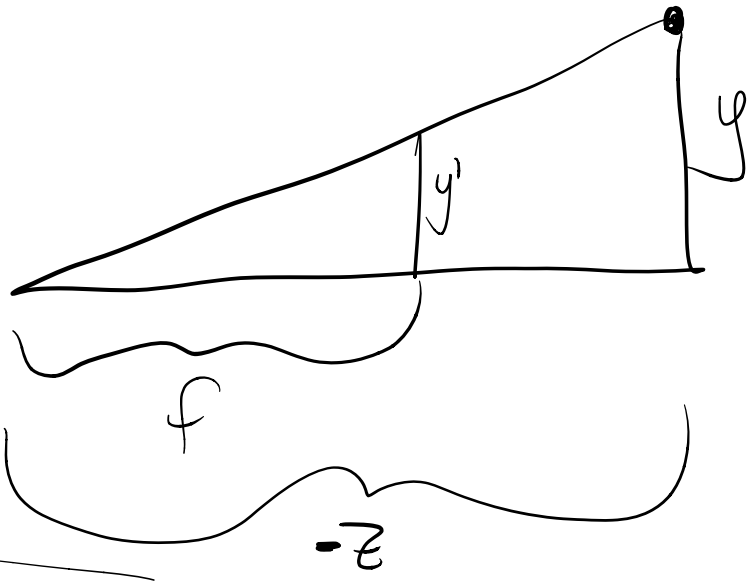
Projection in a Pinhole Camera

- Ms. Collins' geometric (10th grade) way:



$$\frac{y'}{y} = \frac{f}{-z}$$

$$y = y$$



$$y' = -\frac{fy}{z}$$

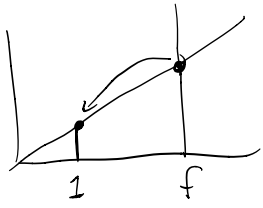
$$x' = -\frac{fx}{z}$$

$$z' = -f$$

← these are 3D (non homogeneous) coordinates.

In the image, the coordinates will be: $\begin{bmatrix} -\frac{fx}{z} \\ -\frac{fy}{z} \\ 1 \end{bmatrix}$

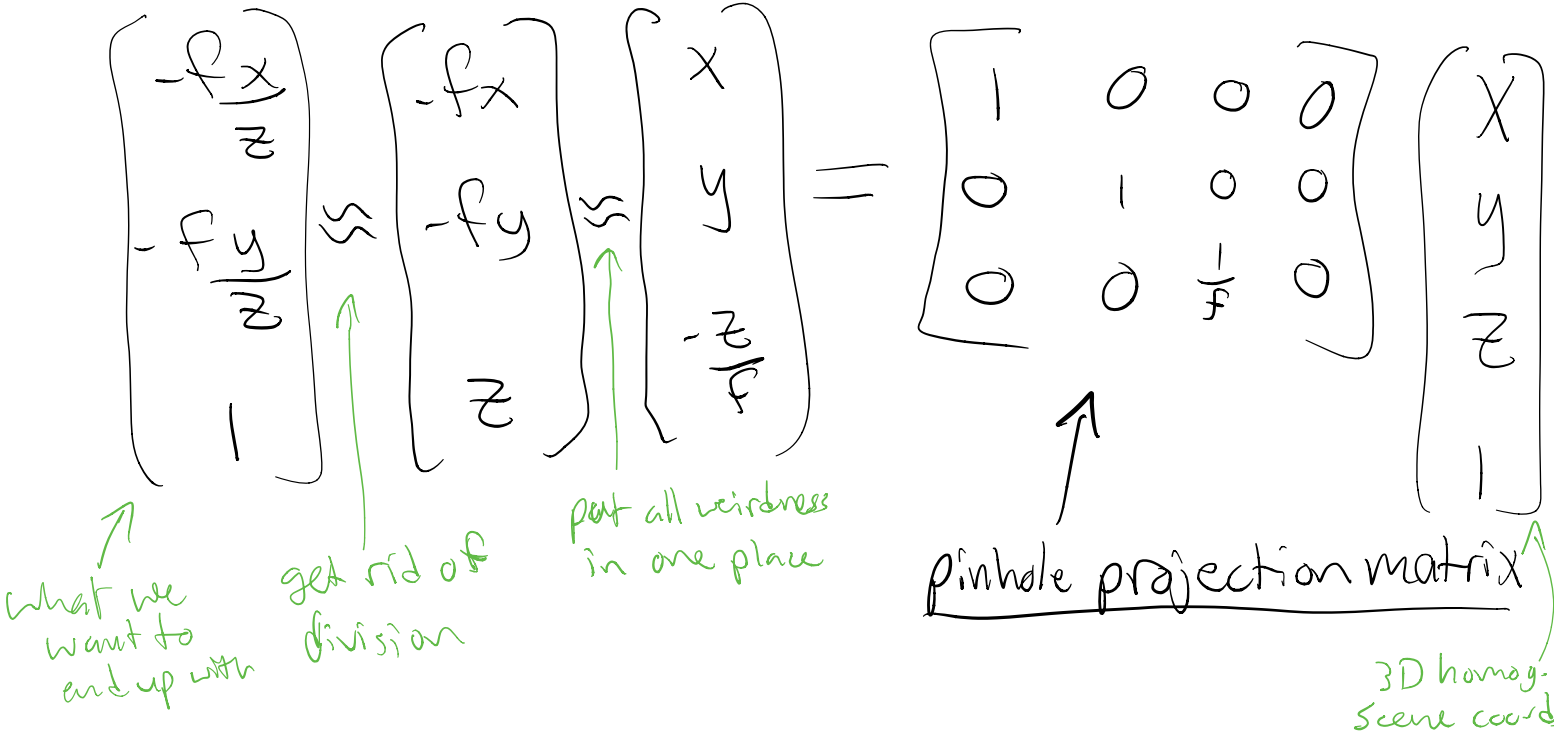
because if we divide out the f, all cameras would have f=1:



Projection in a Pinhole Camera

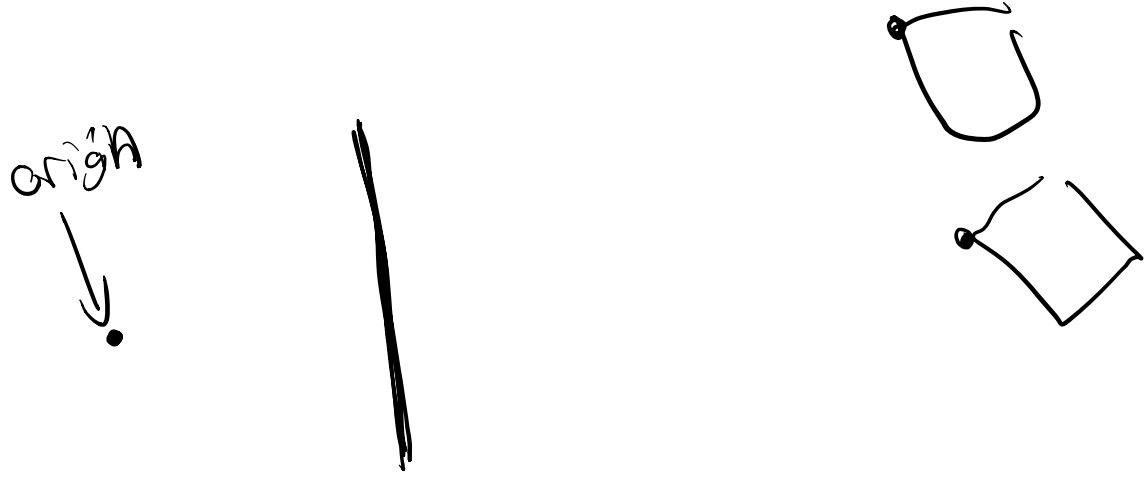
Scott fails 15th grade :-

- Dr. Swenton's (15th grade) way:



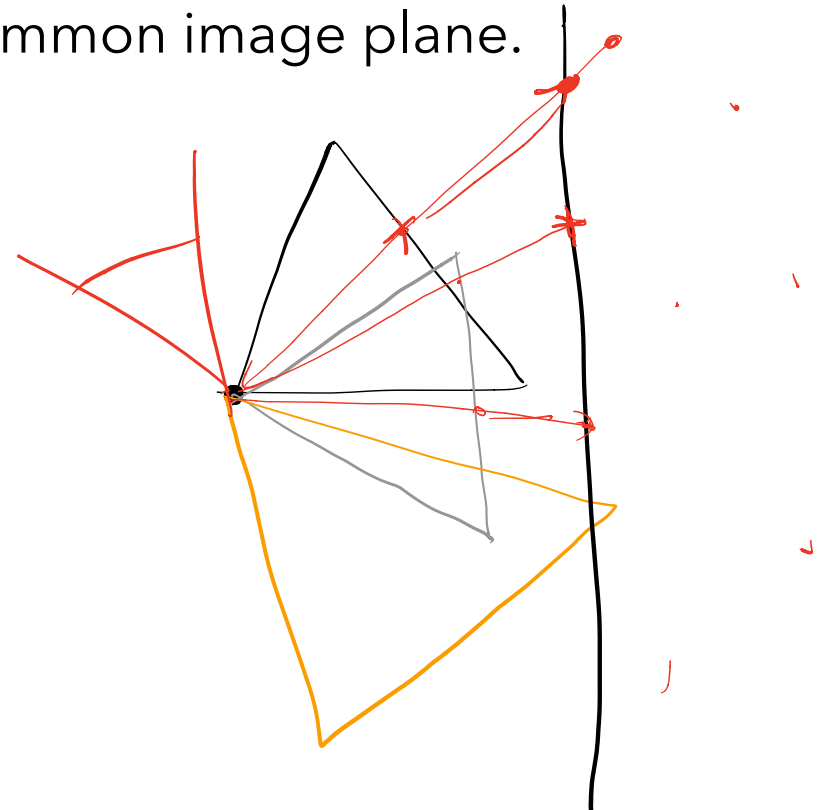
Reinterpreting Homographies

A **3x3 linear transformation**, applied to a projection **plane**.



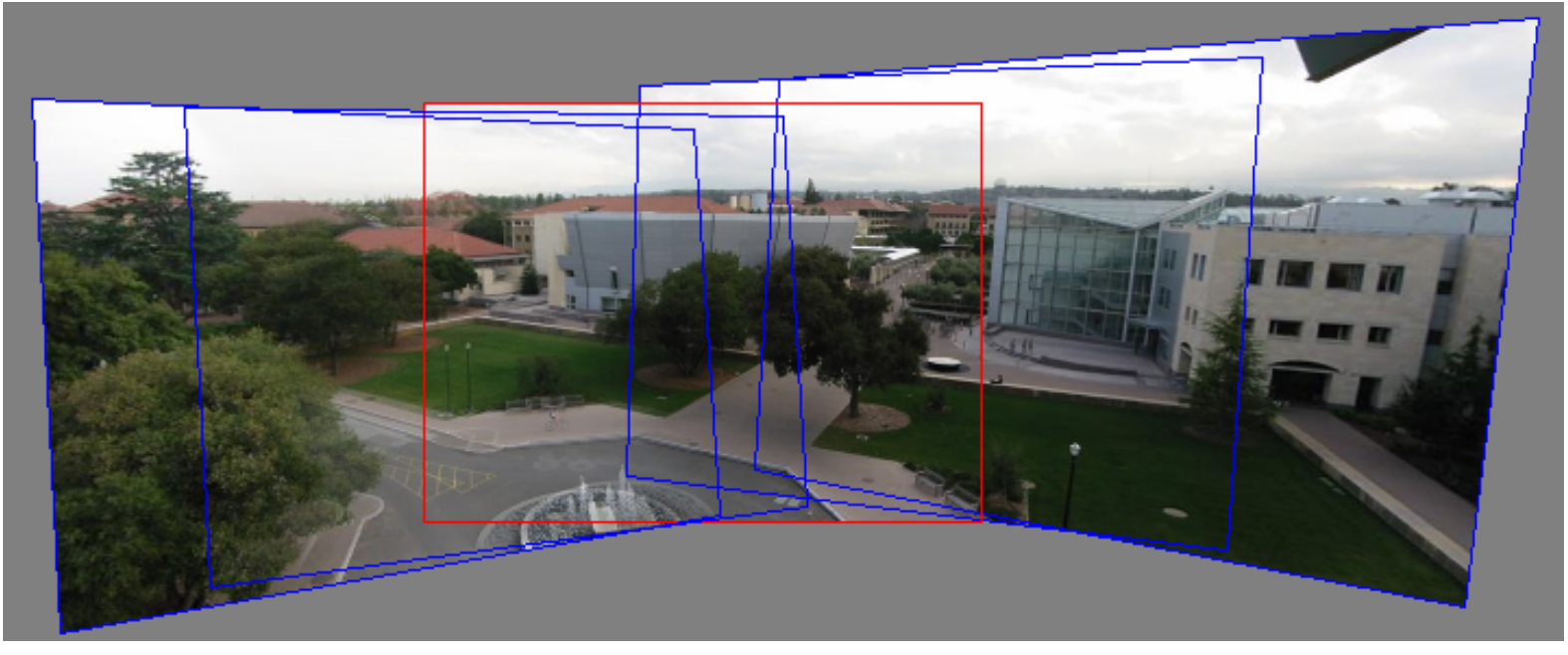
Reinterpreting Homography-aligned Panoramas

- Several image planes are warped (projected) onto a common image plane.



I'll ask it again:

Can we make 360 panoramas?



Spherical Panoramas

Idea: project images onto a **sphere** instead of a plane.

What motion model do we use?