



Stereopsis: Rectification

(New book: 7.2.1,
old book: 11.1)

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CS 6320 Fall 2013

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Course notes modified from:
<http://www.cs.ucf.edu/courses/cap6411/cap5415/>, Lecture 25



CAP5415 - Computer Vision



Material I

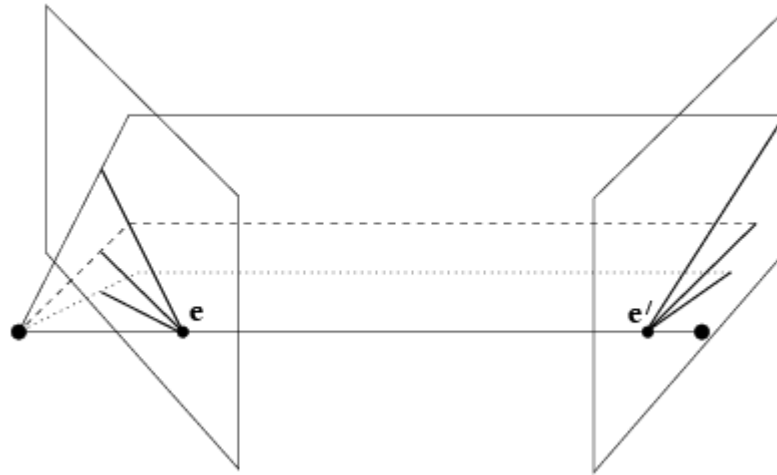
- <http://vision.middlebury.edu/stereo/>
- (online stereo pairs and truth (depth maps))
- Stereo correspondence software: e.g. <http://vision.middlebury.edu/stereo/data/scenes2001/data/imagehtml/tsukuba.html>
- CVonline compendium: <http://homepages.inf.ed.ac.uk/rbf/CVonline/>



Material II

- Epipolar Geometry, Rectification:
- http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/FUSIELLO2/rectif_cvol.html
- and:
http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/OWENS/LECT11/node11.html
- Stereo:
- http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/OWENS/LECT11/lect11.html
- 3D Reconstruction:
- http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/OWENS/LECT11/node8.html

Example: converging cameras



courtesy of Andrew Zisserman



Finding Correspondences



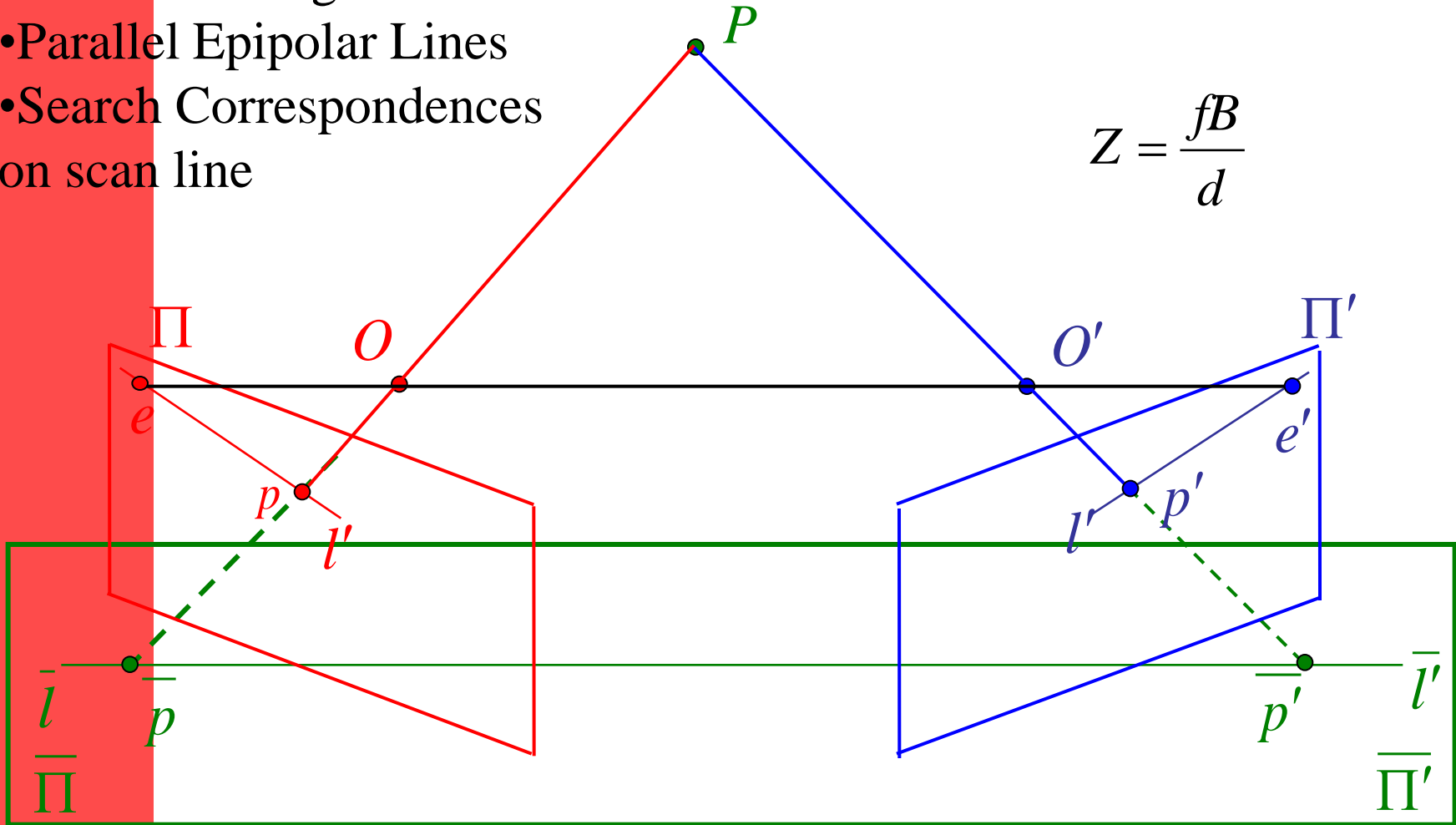
Andrea Fusiello, CVonline



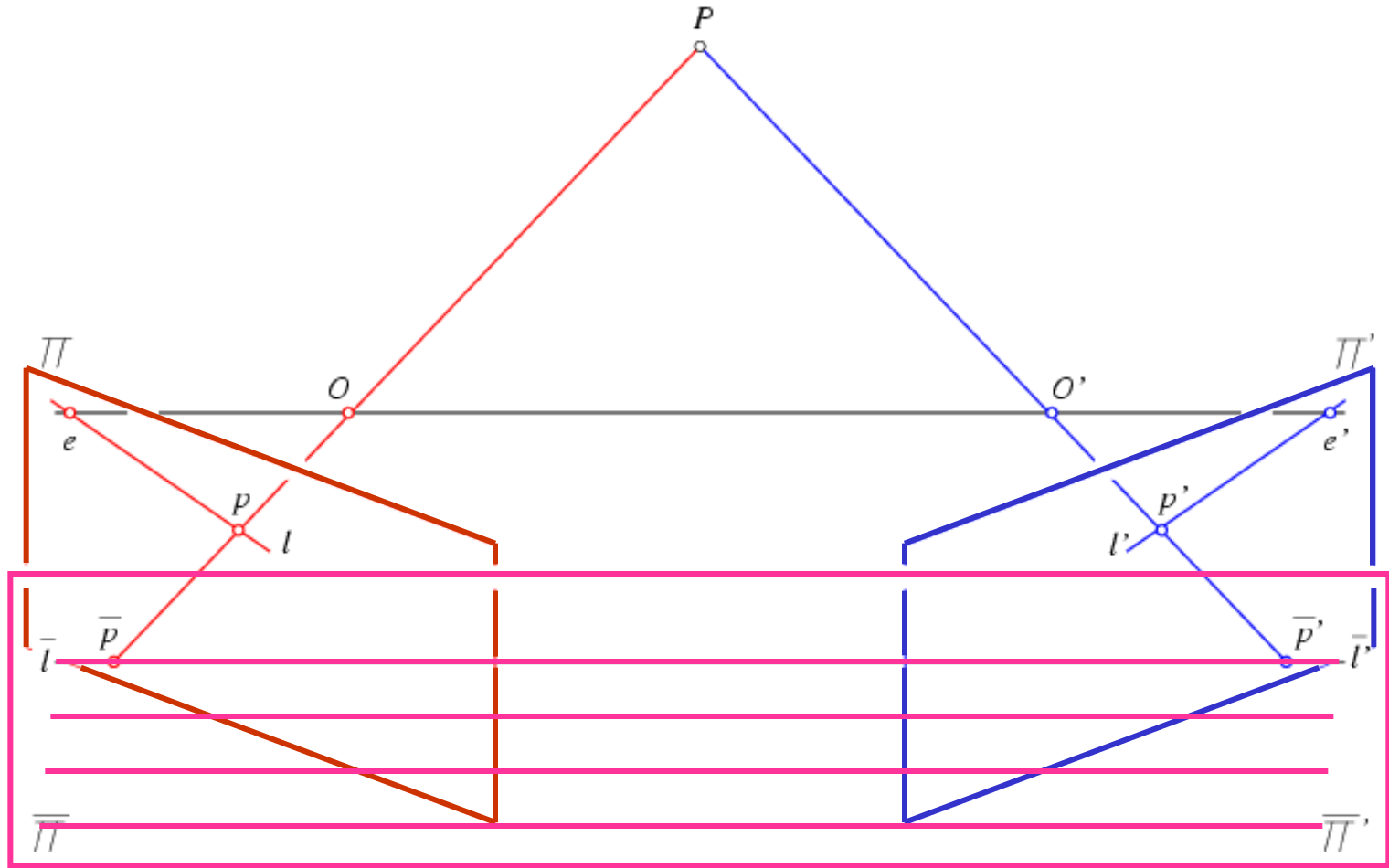
Image Rectification

- Common Image Plane
- Parallel Epipolar Lines
- Search Correspondences on scan line

$$Z = \frac{fB}{d}$$



Rectification



All epipolar lines are parallel in the rectified image plane.



Image Rectification

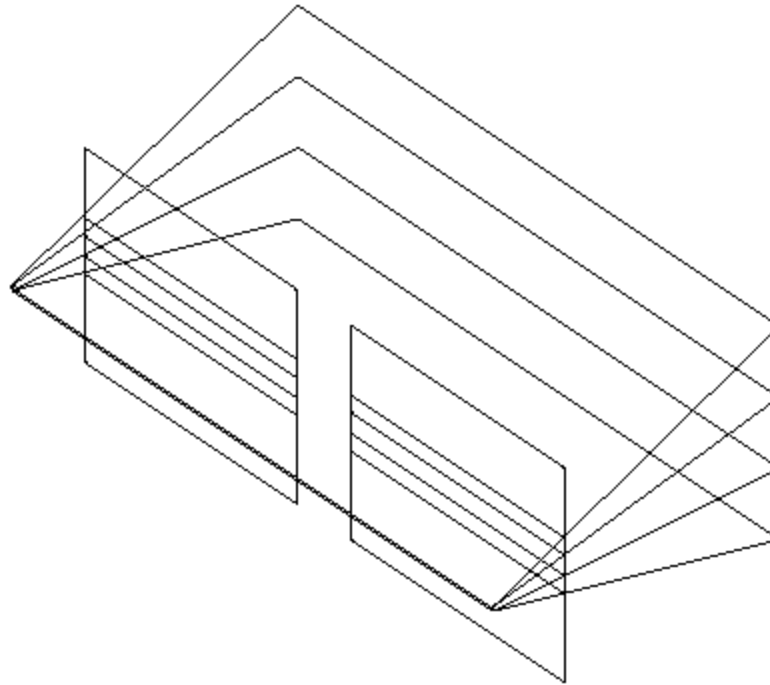


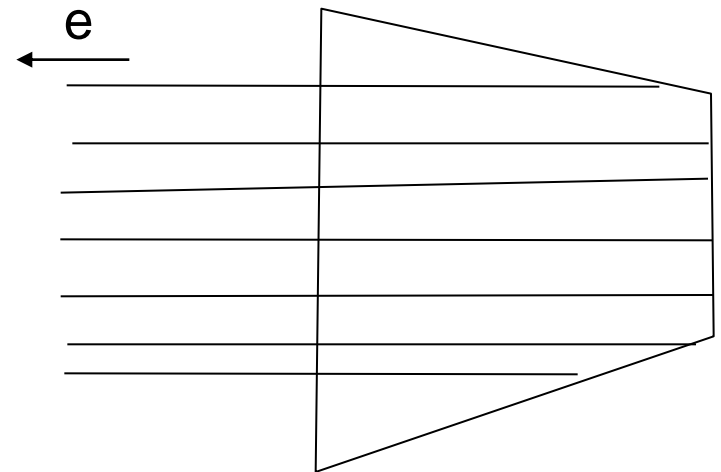
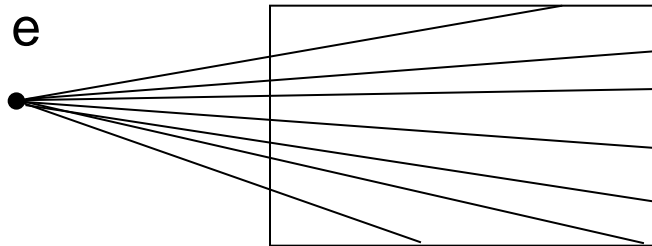
Figure 7.15: Standard stereo setup



Image pair rectification

simplify stereo matching
by warping the images

Apply projective transformation so that epipolar lines
correspond to horizontal scanlines



$$\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = H e$$

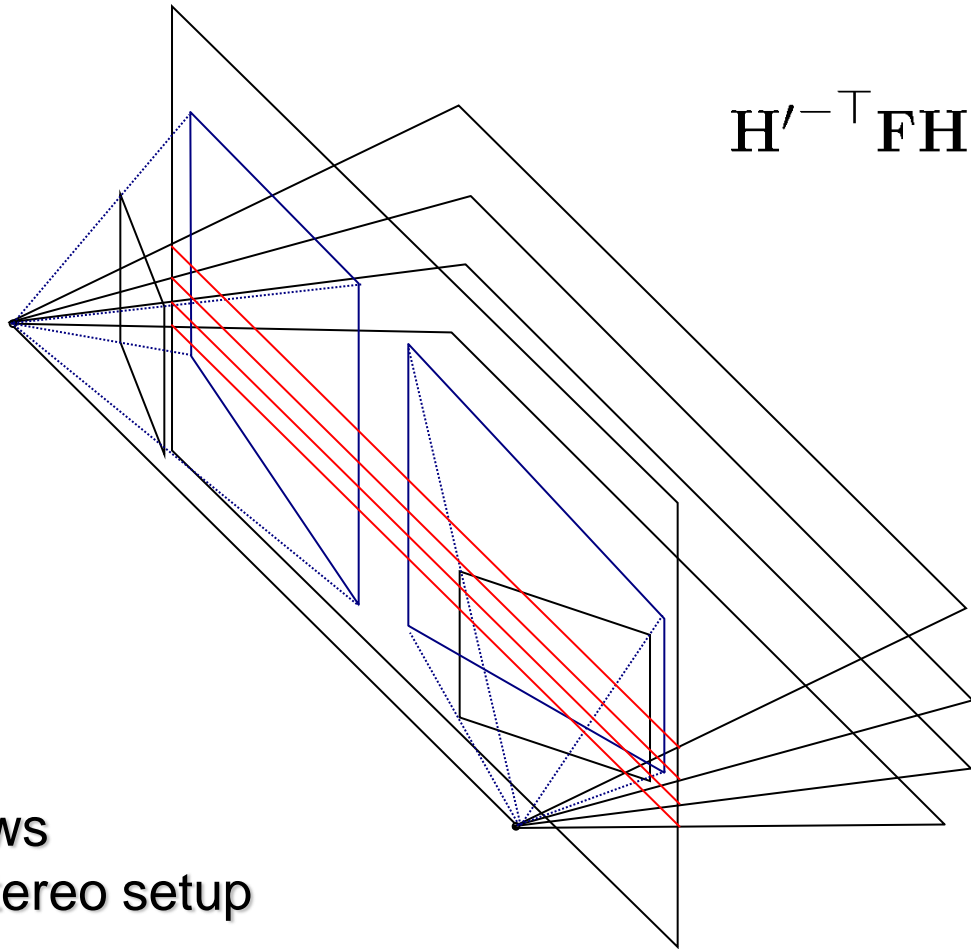
map epipole e to $(1,0,0)$

try to minimize image distortion

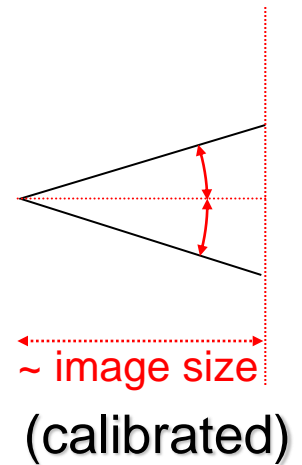
problem when epipole in (or close to) the image



Planar rectification



$$\mathbf{H}'^{-\top} \mathbf{F} \mathbf{H}^{-1} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix}$$



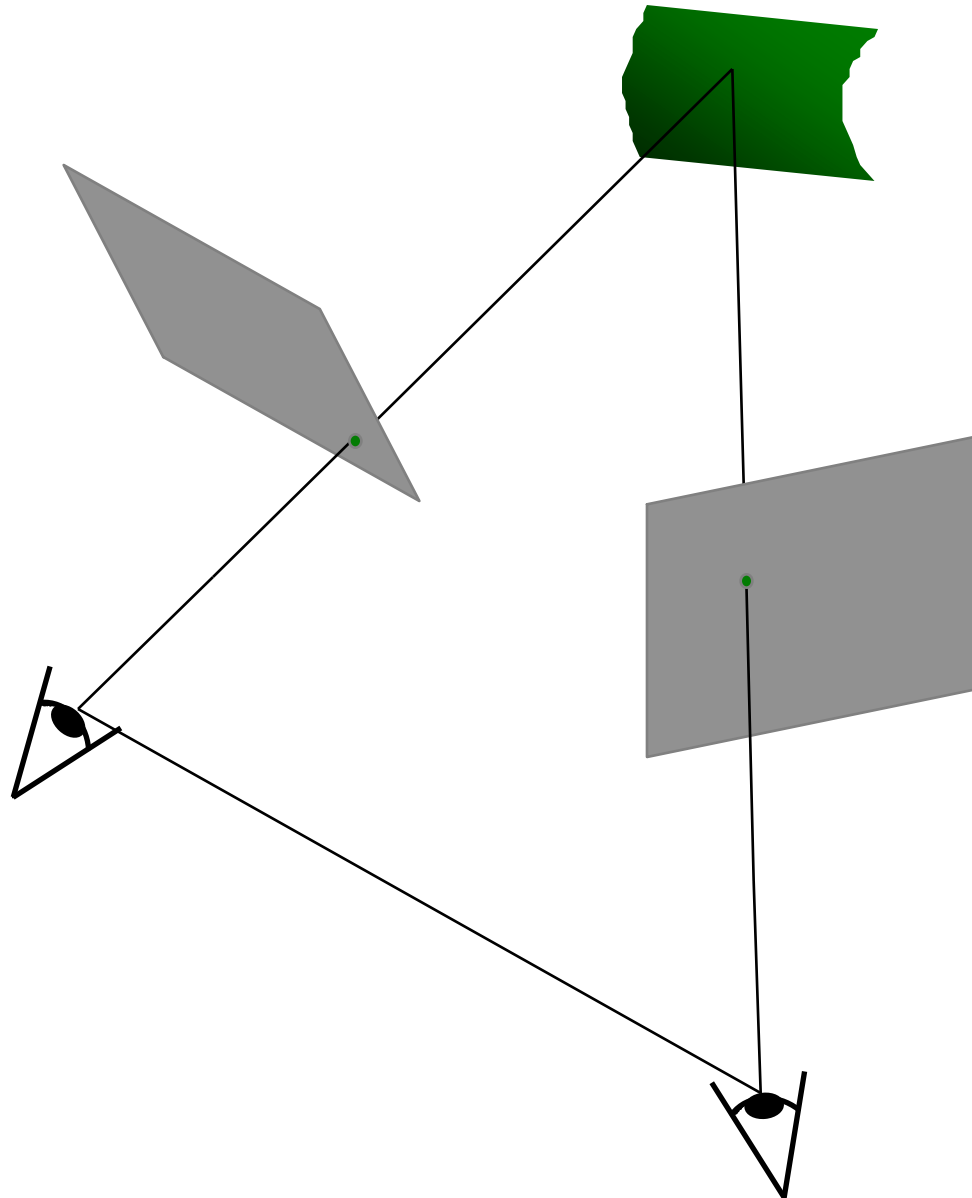
Distortion minimization
(uncalibrated)

Bring two views
to standard stereo setup

(moves epipole to ∞)

(not possible when in/close to image)

Stereo image rectification

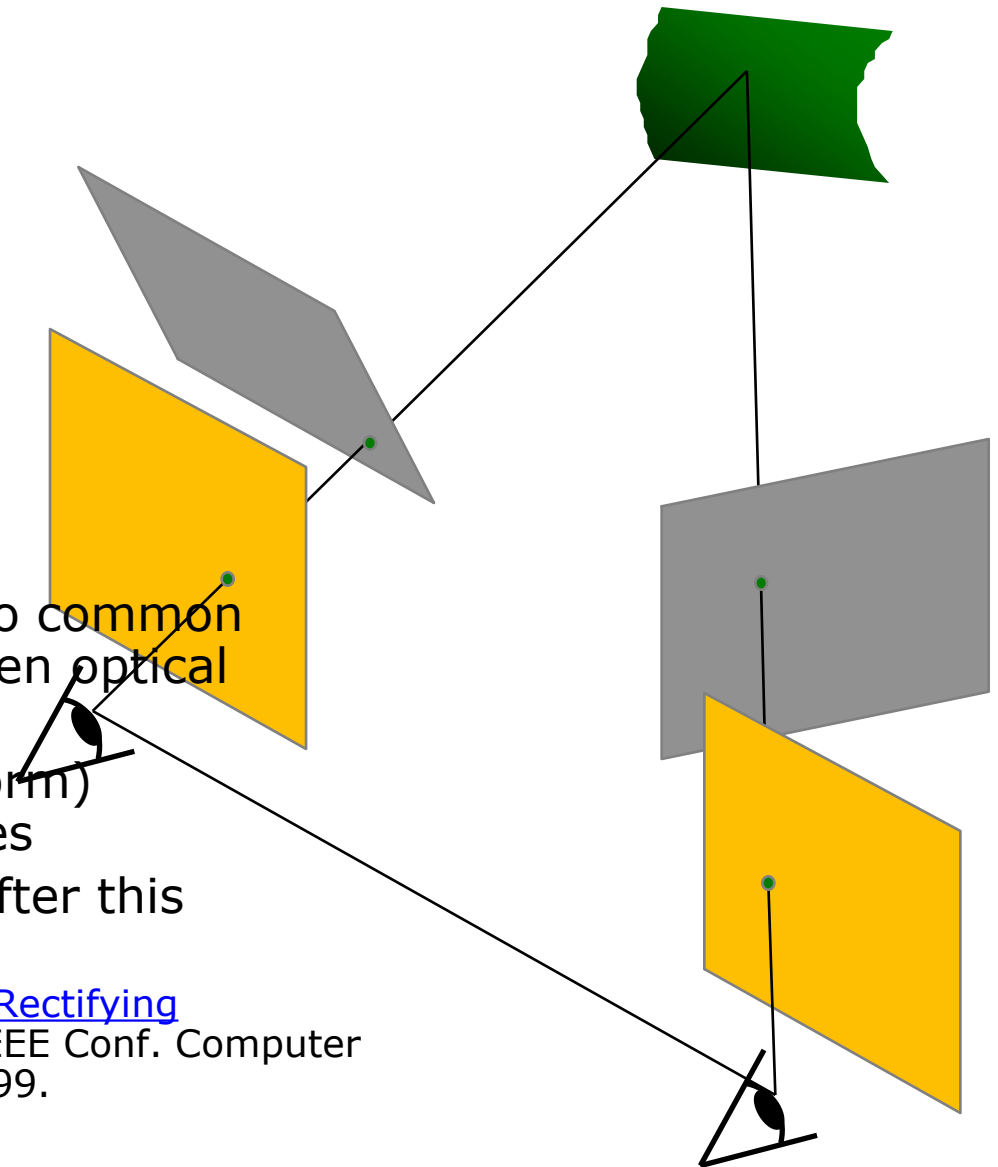




Stereo image rectification

- Image Reprojection

- reproject image planes onto common plane parallel to line between optical centers
- a homography (3x3 transform) applied to both input images
- pixel motion is horizontal after this transformation
- C. Loop and Z. Zhang. [Computing Rectifying Homographies for Stereo Vision](#). IEEE Conf. Computer Vision and Pattern Recognition, 1999.





Rectification ctd.

before



after

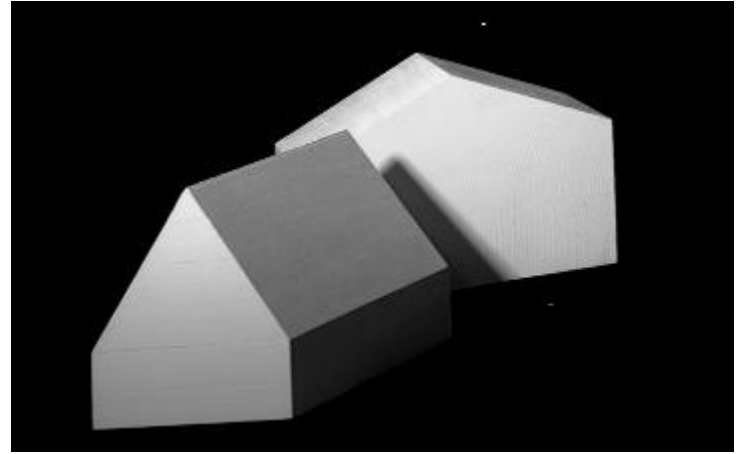
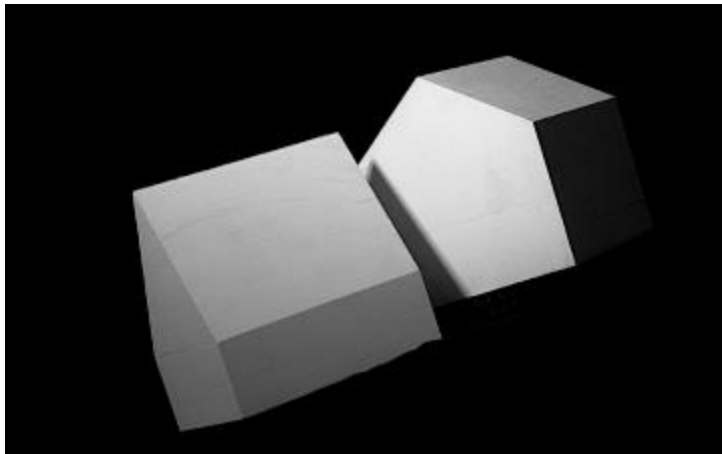
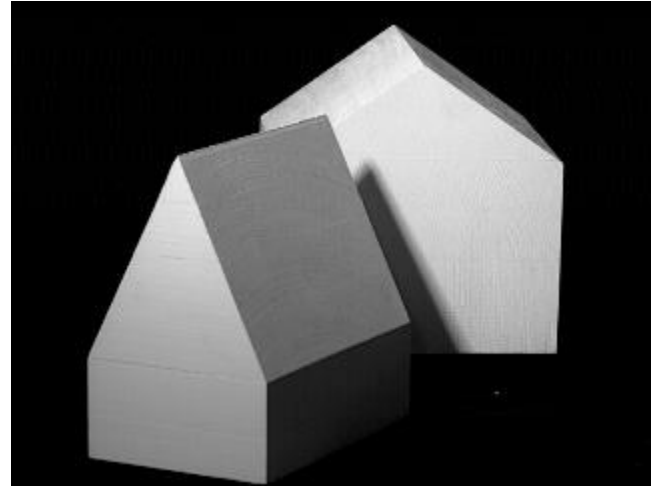
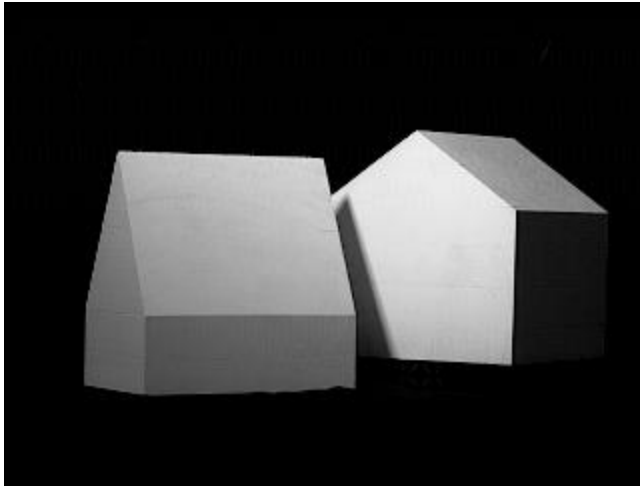


Algorithm Rectification

Following Trucco & Verri book pp. 159

- known T and R between cameras
- Rotate left camera so that epipole e_l goes to infinity along horizontal axis
- Apply same rotation to right camera to recover geometry
- Rotate right camera by R^{-1}
- Adjust scale







Stereo matching with general camera configuration

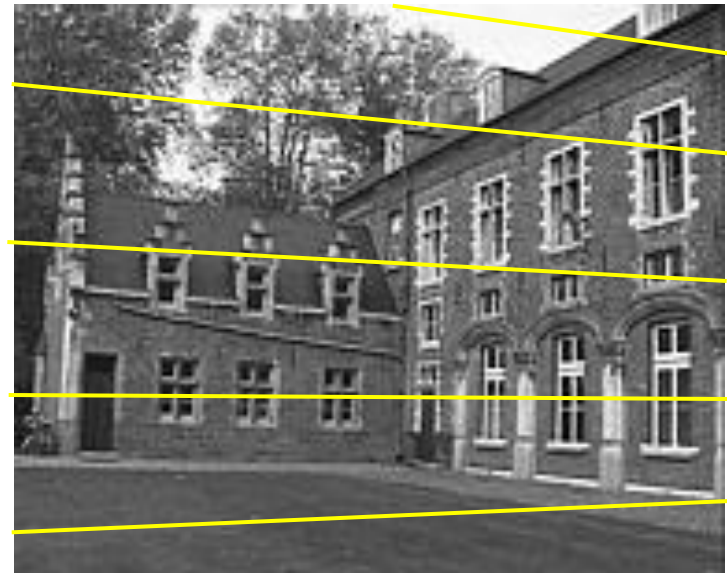
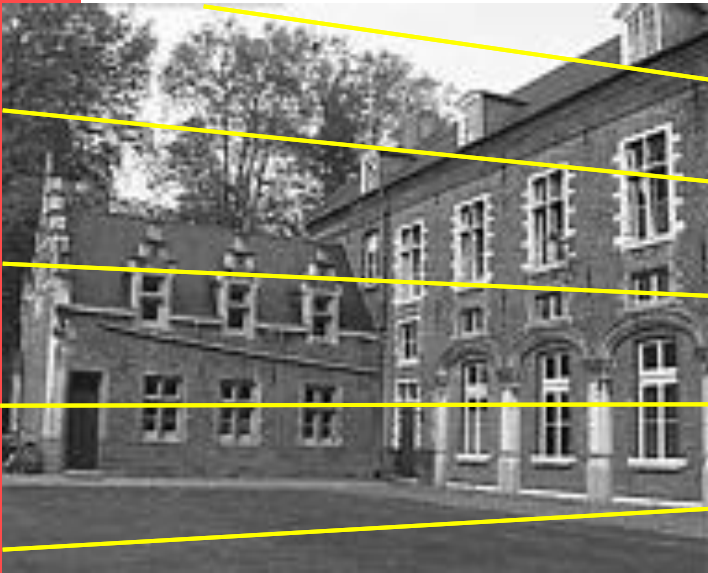
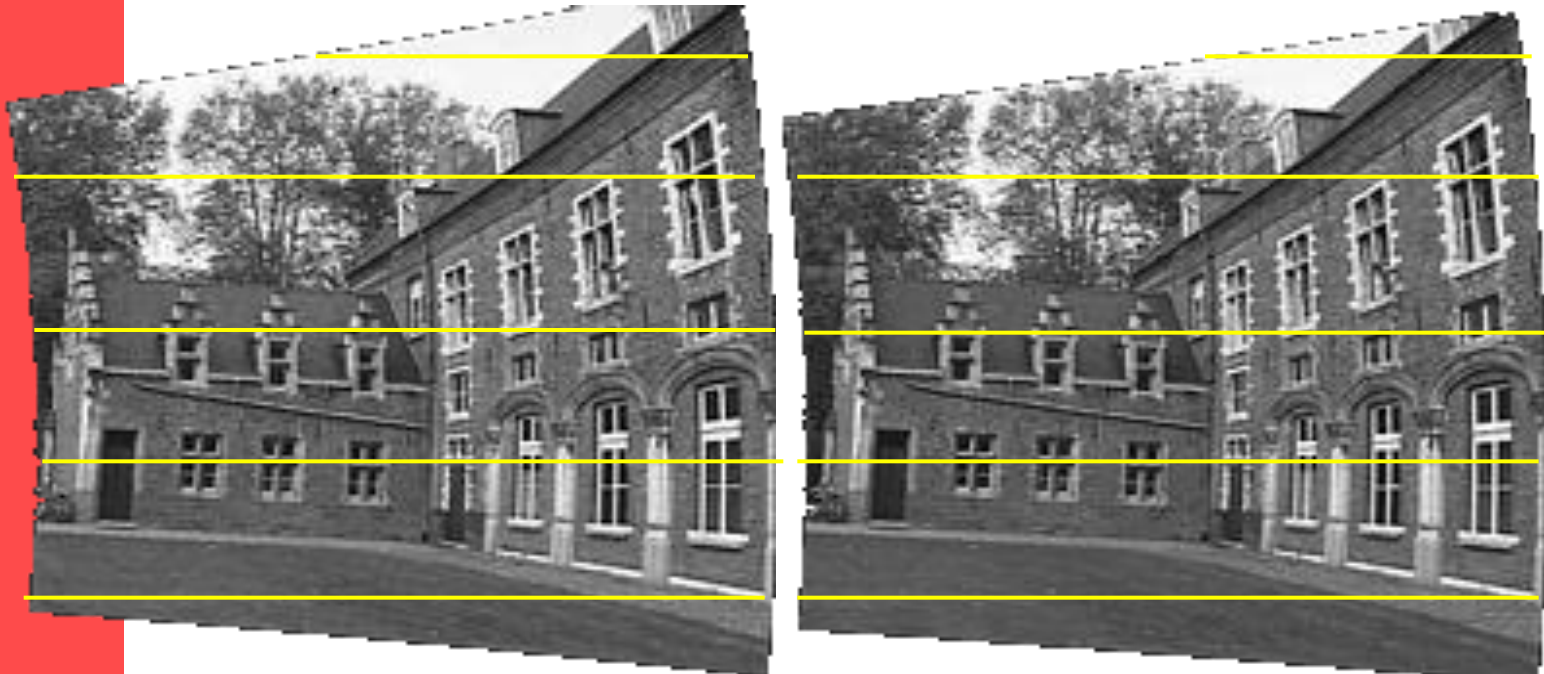




Image pair rectification

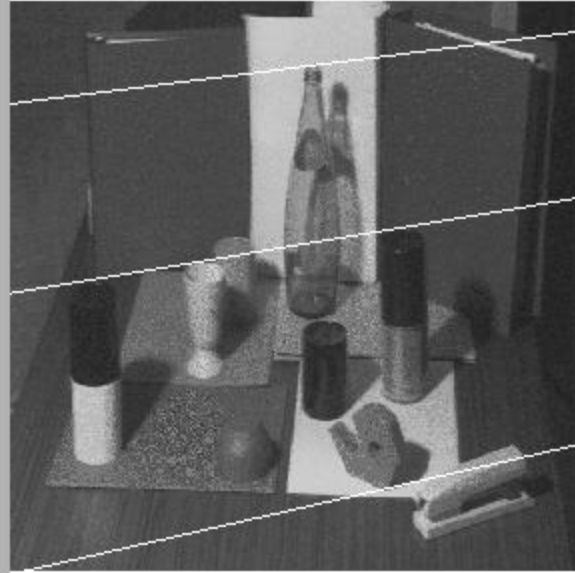




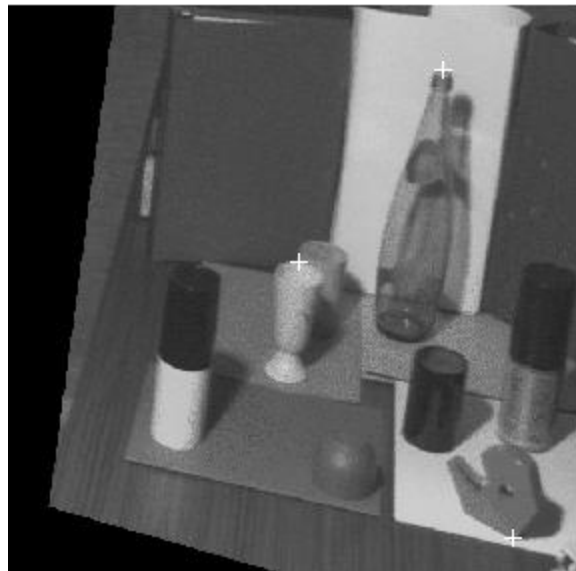
Left image



Right image



Rectified left image



Rectified right image





Other Material /Code

- Epipolar Geometry, Rectification:
- http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/FUSIELLO2/rectif_cvol.html
- Trucco & Verri:
- <http://profs.sci.univr.it/~fusiello/demo/rect/>