

# Auto-calibration

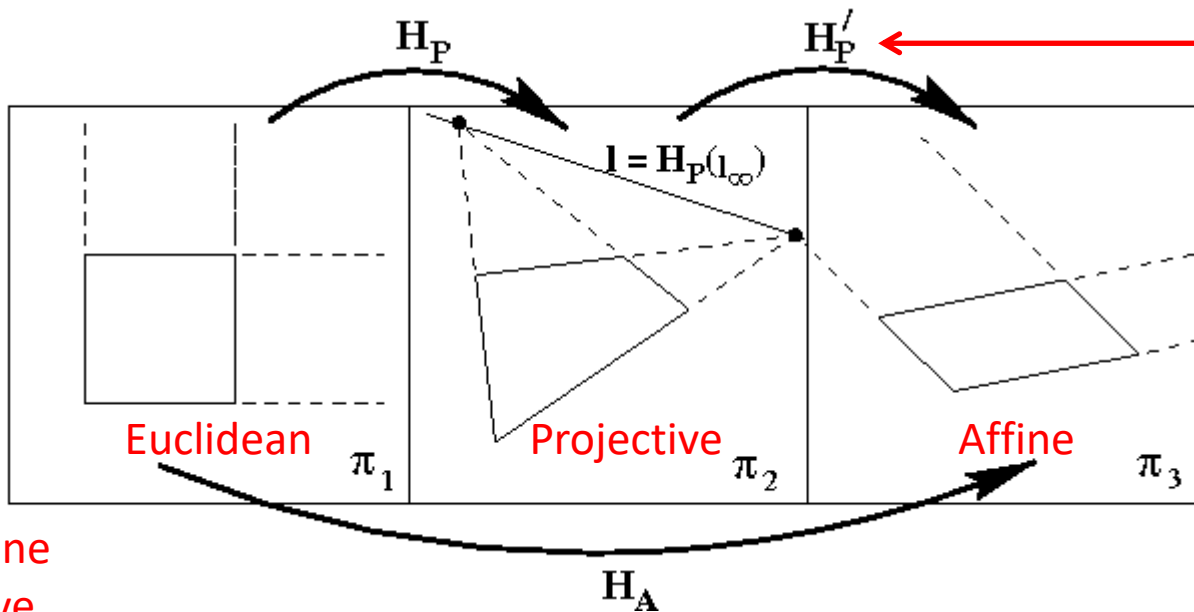
Computer Vision II

CSE 252B

# 2D Affine Rectification

Solve for planar projective transformation that maps line (back) to line at infinity

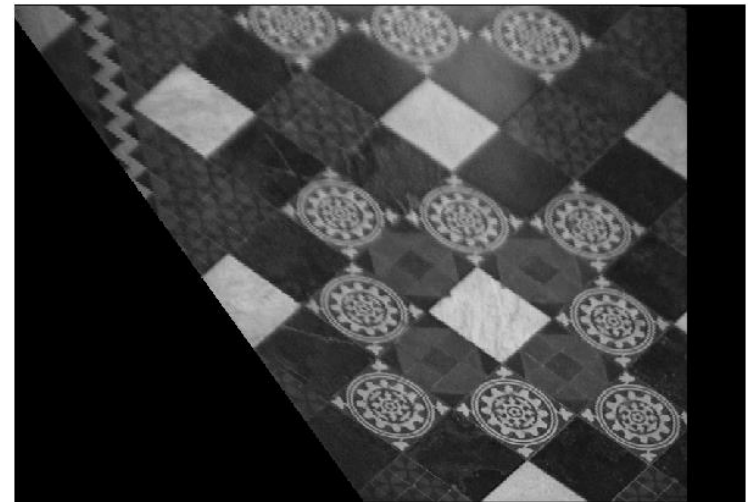
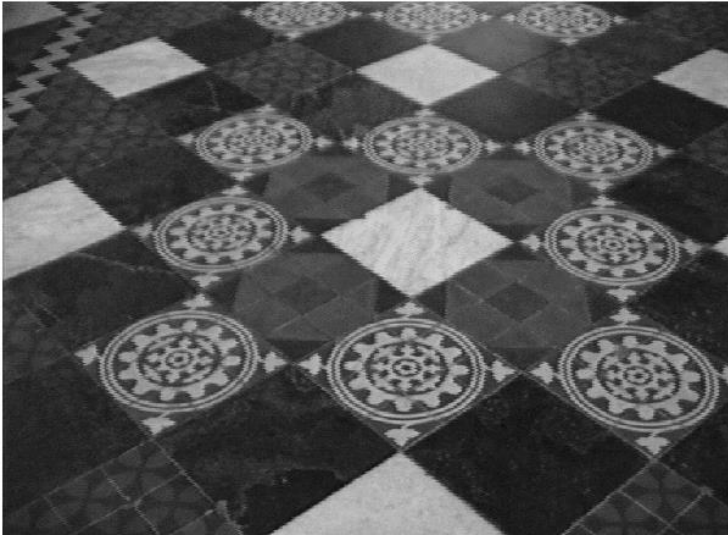
Solve as a Householder matrix



The vanishing line in the projective frame corresponds to the line at infinity in the Euclidean frame

The line at infinity is fixed under a planar affine transformation

# 2D Affine Rectification Using The Vanishing Line

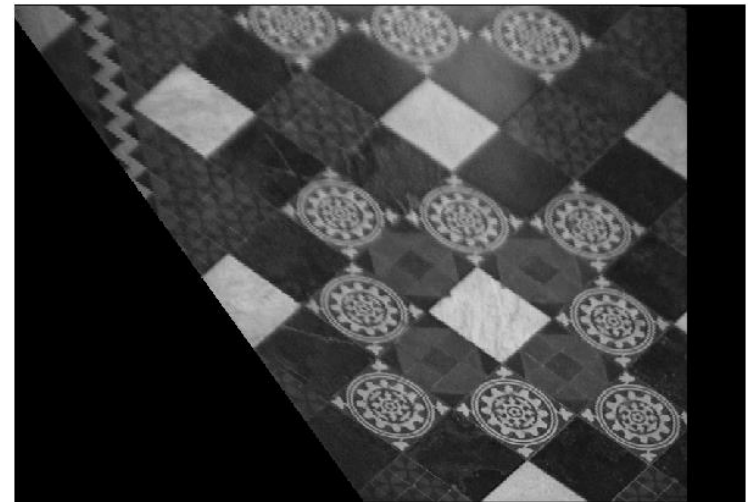


Vanishing line is join of vanishing points

The vanishing line  
in the projective  
frame  
corresponds to  
the line at infinity  
in the Euclidean  
frame

Vanishing points from intersection of parallel lines

# 2D Affine Rectification Using The Vanishing Line

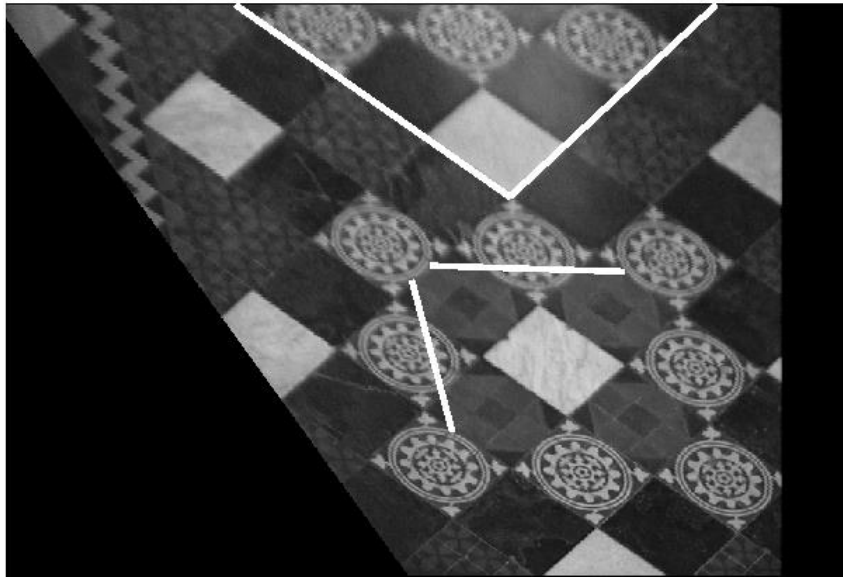


Vanishing line is join of vanishing points

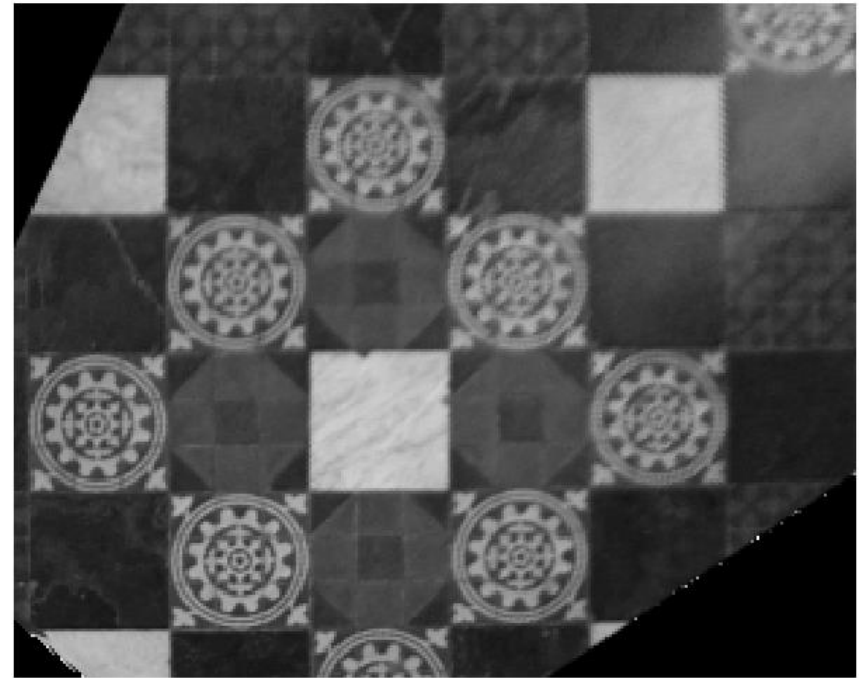
The vanishing line  
in the projective  
frame  
corresponds to  
the line at infinity  
in the Euclidean  
frame

Vanishing points from equal length ratios

# From Affine to Metric Rectification



Two imaged orthogonal line pairs



Solve for absolute dual conic

Stratified: projective  $\rightarrow$  affine  $\rightarrow$  similarity

# Alternatively: Projective to Metric



Five imaged orthogonal line pairs

Solve for absolute dual conic

# Plane at Infinity in 3D is Analogous to Line at Infinity in 2D

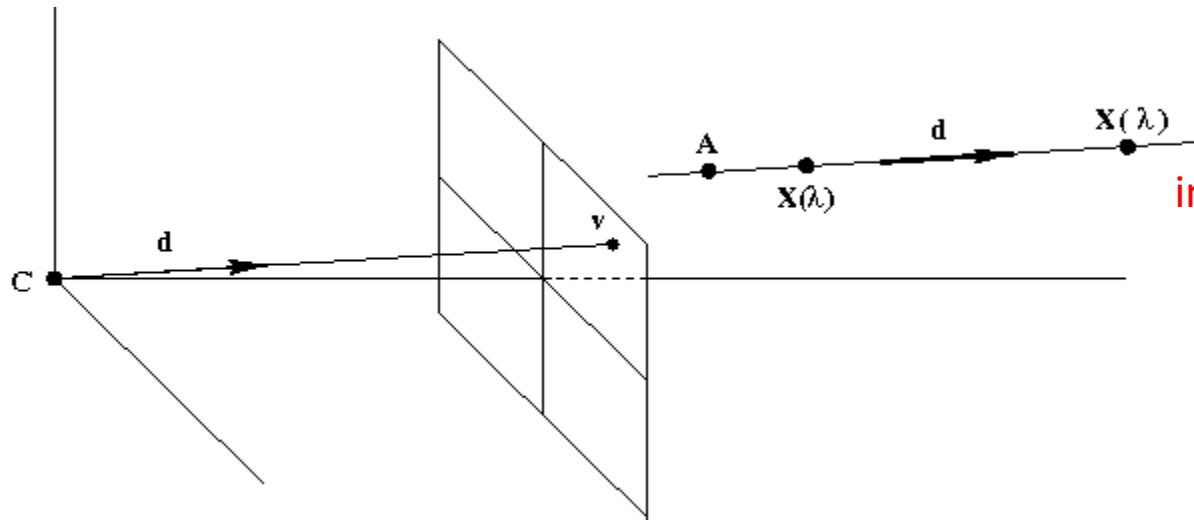
- 2D
  - Solve for planar projective transformation that maps line (back) to line at infinity
  - The line at infinity is fixed under a planar affine transformation
- 3D
  - Solve for 3D projective transformation that maps plane (back) to plane at infinity
  - The plane at infinity is fixed under a 3D affine transformation

# Properties of the Plane at Infinity

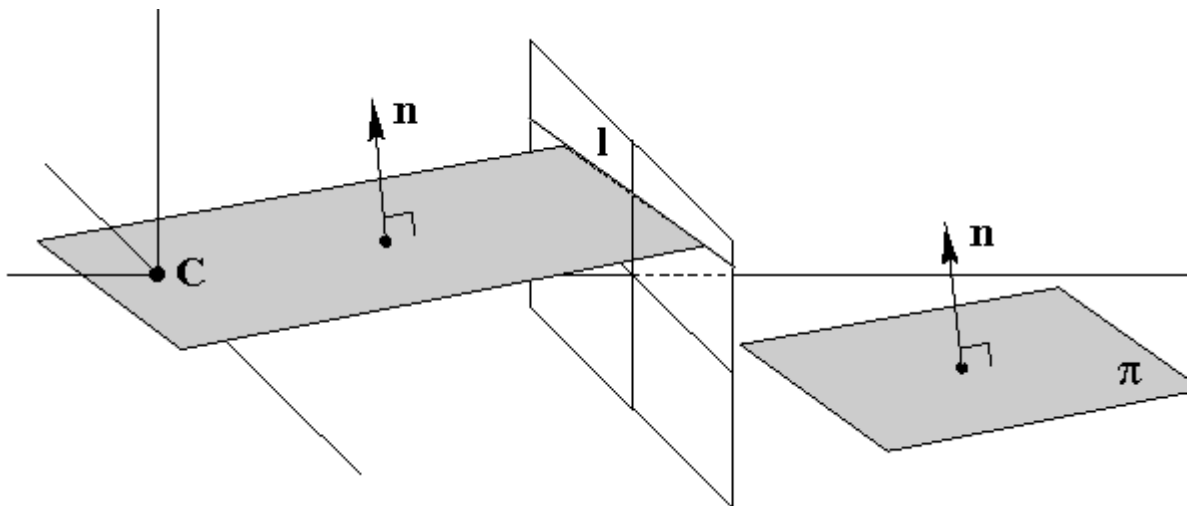
- Two planes are parallel if, and only if, their line of intersection is on the plane at infinity
- A line is parallel to another line, or to a plane, if the point of intersection is on the plane at infinity
- A plane intersects the plane at infinity in a line on the plane that corresponds to the line at infinity



# Parallel 3D Lines and Planes



Point of intersection is on the plane at infinity

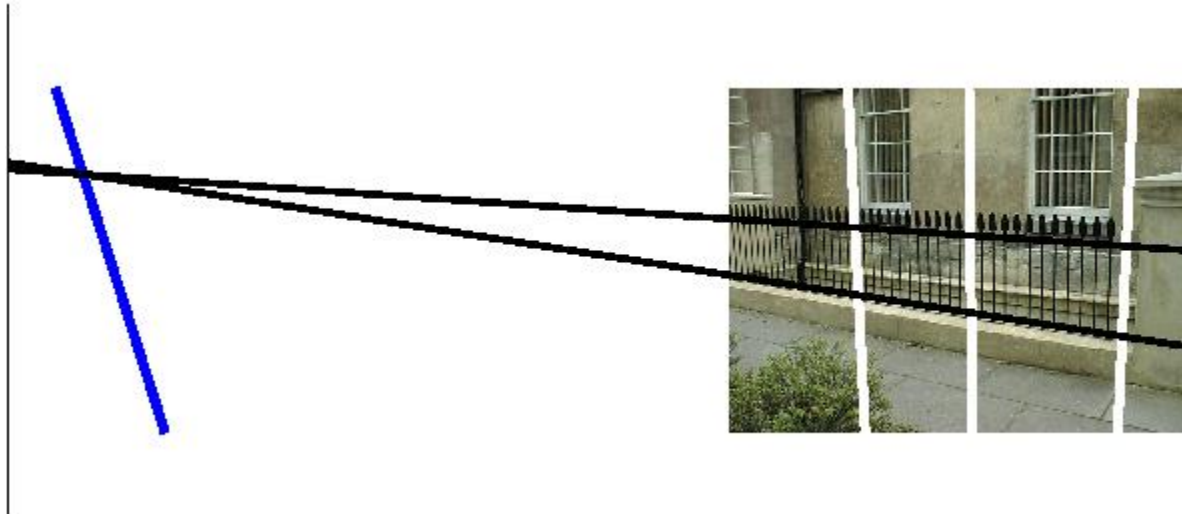


Line of intersection is on the plane at infinity

# Identify the Plane at Infinity

- Three or more points on the plane in the projective frame that corresponds to the plane at infinity in the Euclidean frame determine the plane
- Three or more sets of parallel lines in the projective frame determine three or more points on the plane that corresponds to the plane at infinity in the Euclidean frame
- Distance ratios on a line in 3D (similar to 2D)

# Vanishing Points and Vanishing Lines



Note that the vanishing point lies on the vanishing line

# Vanishing Points and Vanishing Lines



# Plane at Infinity in 3D is Analogous to Line at Infinity in 2D

- 2D
  - Solve for planar projective transformation that maps line (back) to line at infinity
  - The line at infinity is fixed under a planar affine transformation
- 3D
  - Solve for 3D projective transformation that maps plane (back) to plane at infinity
  - The plane at infinity is fixed under a 3D affine transformation

# Absolute Dual Quadric in 3D is Analogous to Absolute Dual Conic in 2D

- 2D
  - Solve for absolute dual conic from images of orthogonal line pairs
  - The absolute dual conic is fixed under a planar similarity transformation
- 3D
  - Solve for absolute dual quadric
    - Solve for the image of the absolute conic (IAC) ( $= (KK^T)^{-1}$ )
  - The absolute dual quadric is fixed under a 3D similarity transformation