Auto-calibration

Computer Vision II
CSE 252B
2D Affine Rectification

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

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

Solve as a Householder matrix
2D Affine Rectification
Using The Vanishing Line

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

Vanishing points from intersection of parallel lines

Vanishing line is join of vanishing points
2D Affine Rectification
Using The Vanishing Line

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

Vanishing line is join of vanishing points

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) (= (KKT)^{-1})
  – The absolute dual quadric is fixed under a 3D similarity transformation