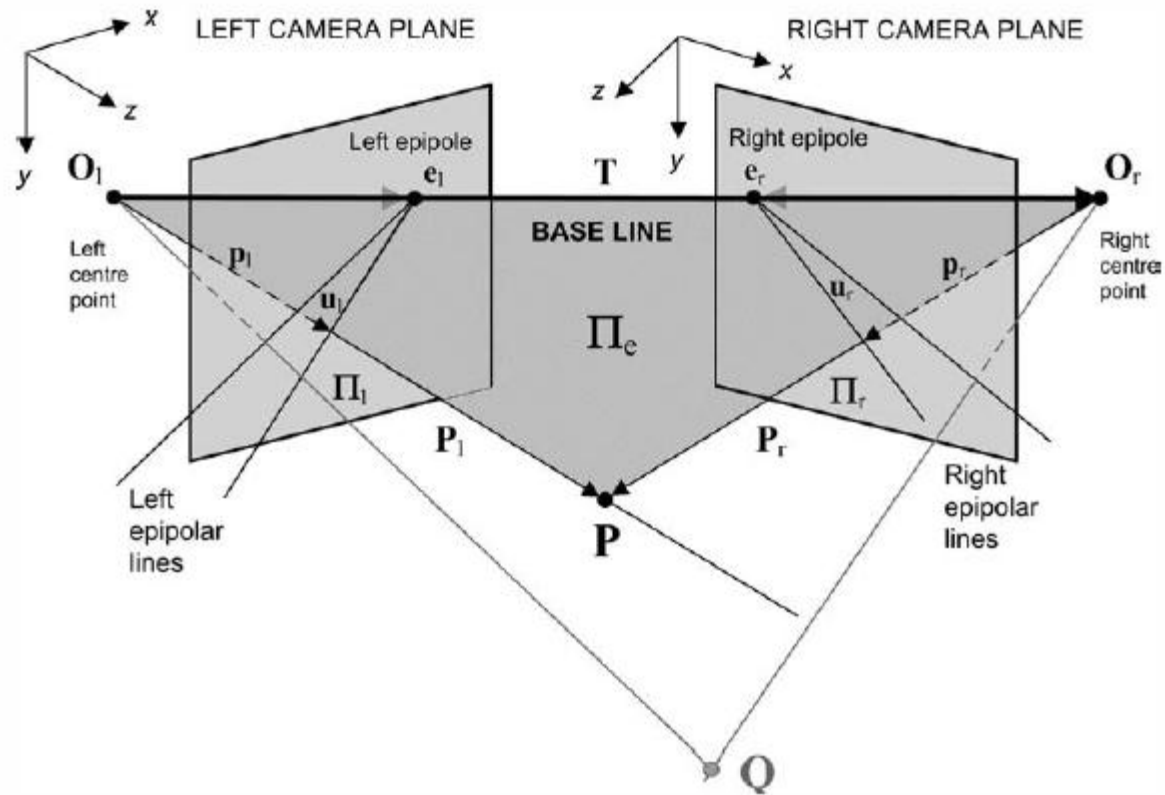


# Multi View Geometry as Task of Computational Intelligence

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# Epipolar geometry



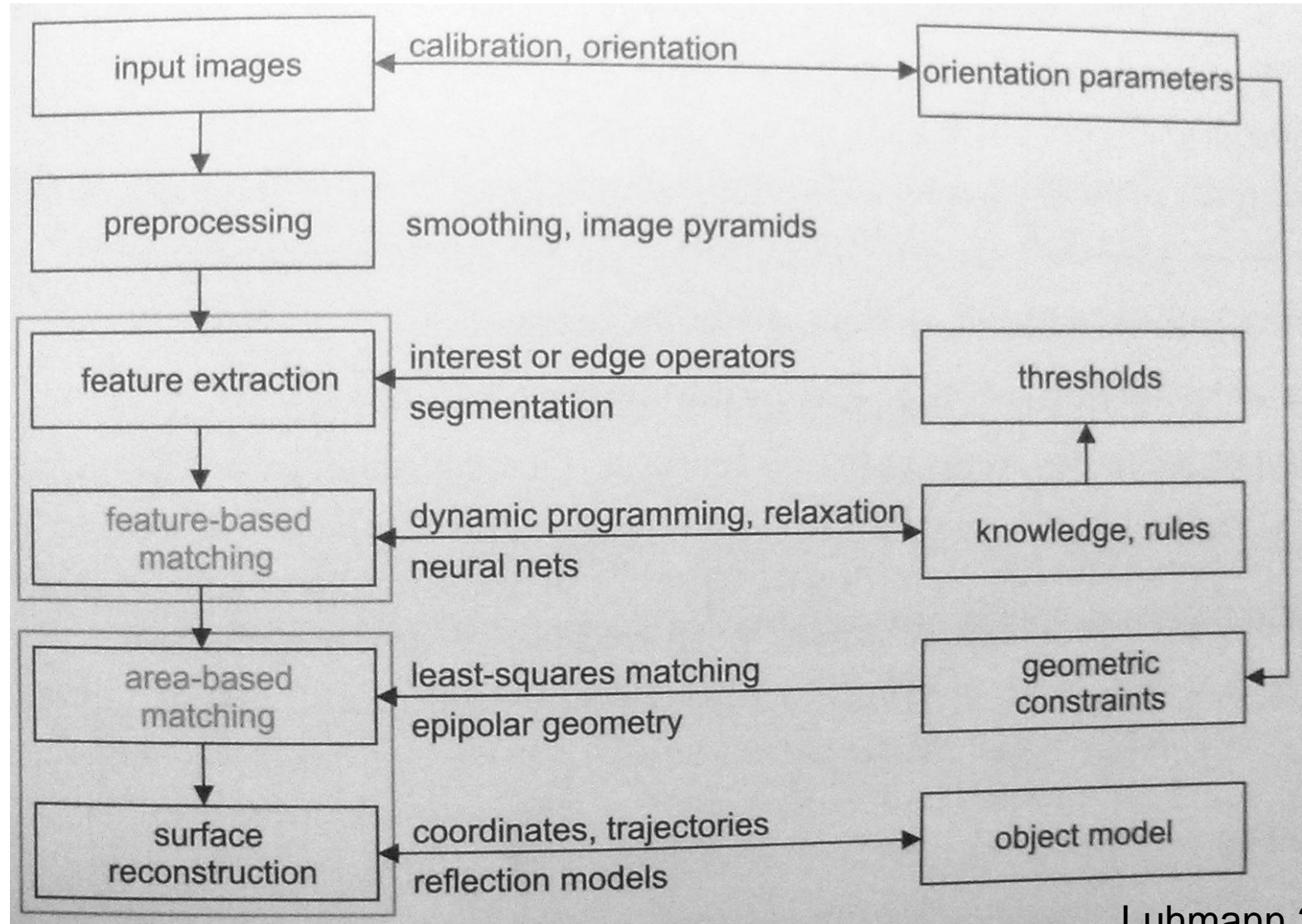
# Multi view example



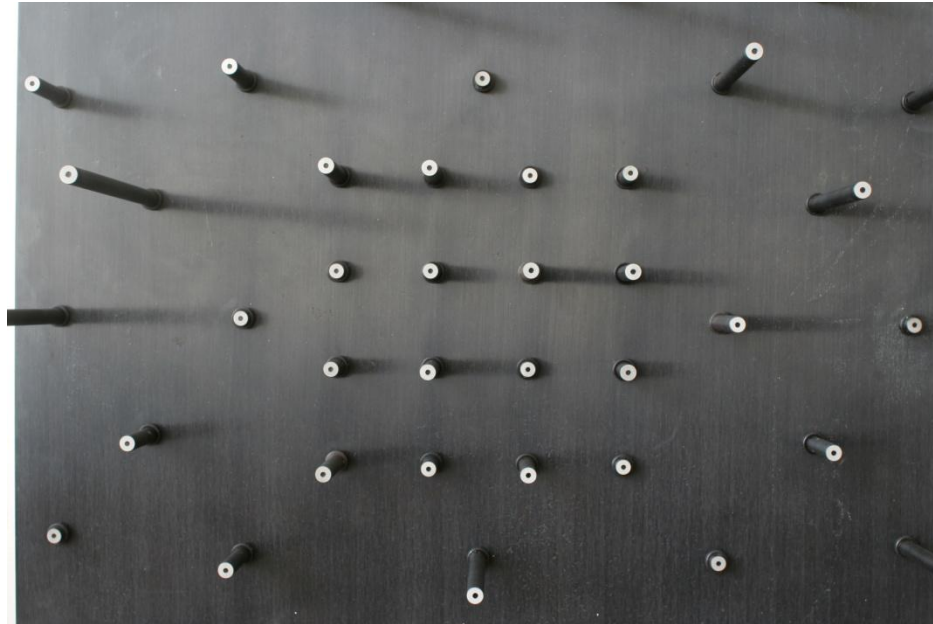
# Image matching

- Identification of image points for 3D point measurement
- Identification of homologous images features for 3D surface reconstruction
- Tracking of objects in image sequences

# Strategy for image matching



# Calibration



(a)



(b)

(bottom photos) Goshtasby 2005

# Preprocessing

- Image pyramids
  - Octave gaussian scale



Cyganek 2009

# Feature extraction

- Corners
- Edges
- Symbols



# Preconditions for object acquisition

- Intensities in all images cover the same spectral regions
- Constant illumination
- Stable object surface
- Macroscopically smooth object surface
- Opaque object surface
- Know approximate values for orientation data and object data

# Edges detection

- Sobel filtration
- Binarization



# Uniform object

Original image



Edges detection

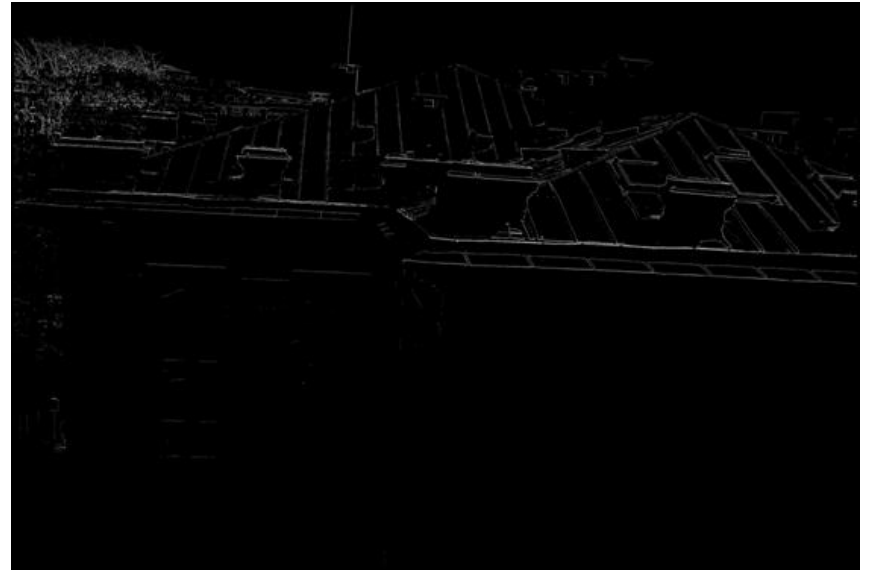


# Illuminated object

**Original image**



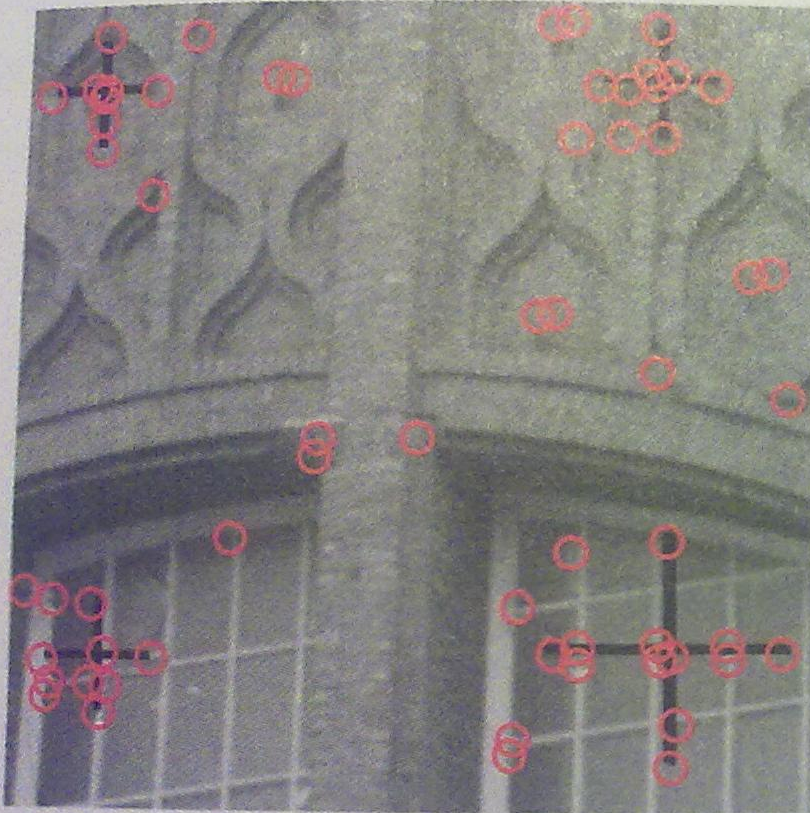
**Edges detection**



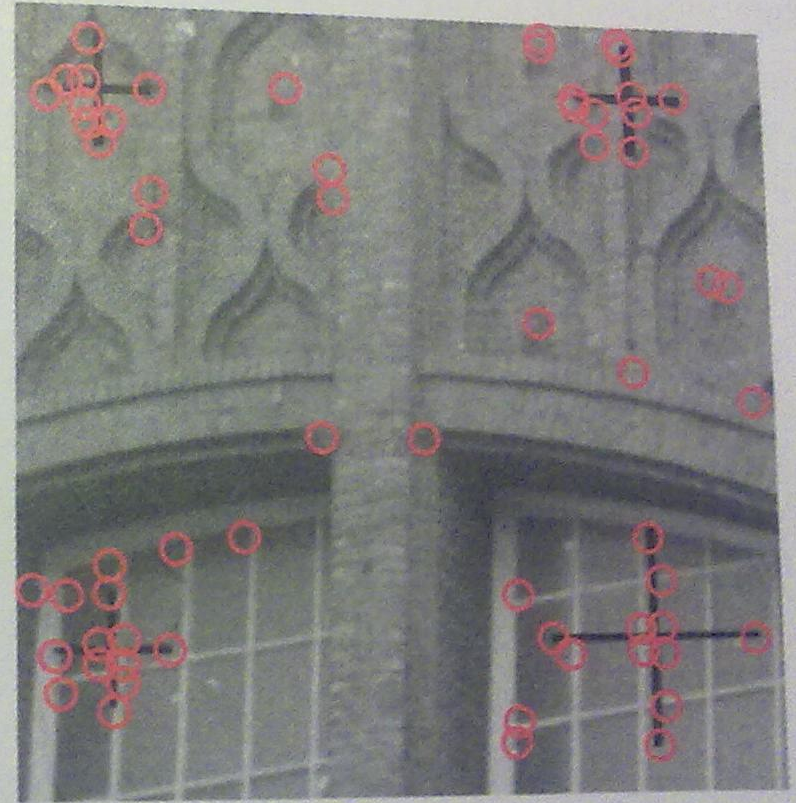
# Corners detectors

- Moravec operator
  - Mean square sums of gradients within the four principal directions
  - Calculated in window
  - Not rotation invariant
- Harris operator
  - Smoothed first derivatives
- Förstner operator
  - Calculates the covariance matrix of the displacement of an image windows
  - Error ellipse becomes small and circular for distinctive features

# Corners detection



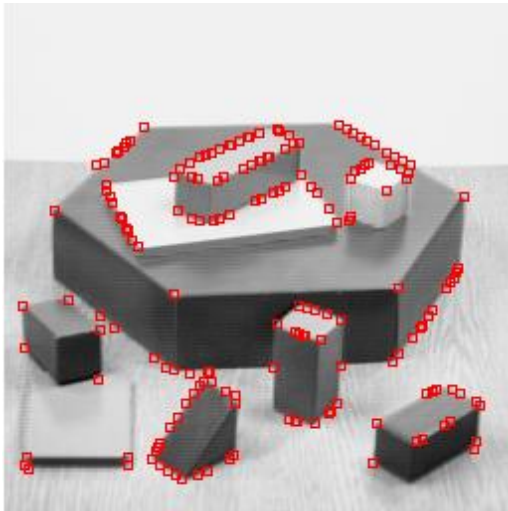
a) Moravec operator (filter size  $5 \times 5$ ,  $v_{\min} = 100$ )



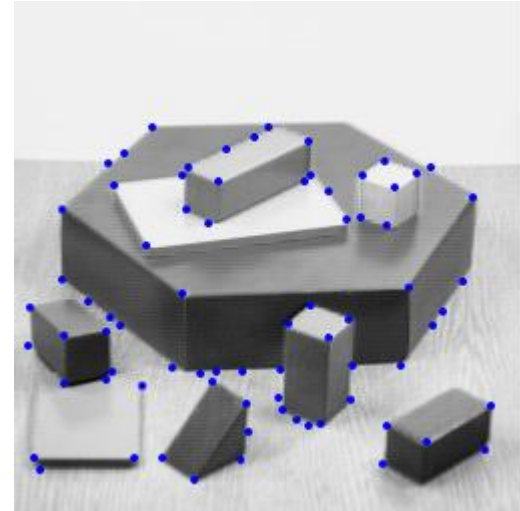
b) F\u00f6rstner operator (filter size  $7 \times 7$ ,  
 $w_{\min} = 1.0 \times w_{\text{mean}}$ ,  $q_{\min} = 0.5$ )

# Corners detection

**Moravec**



**Harris**

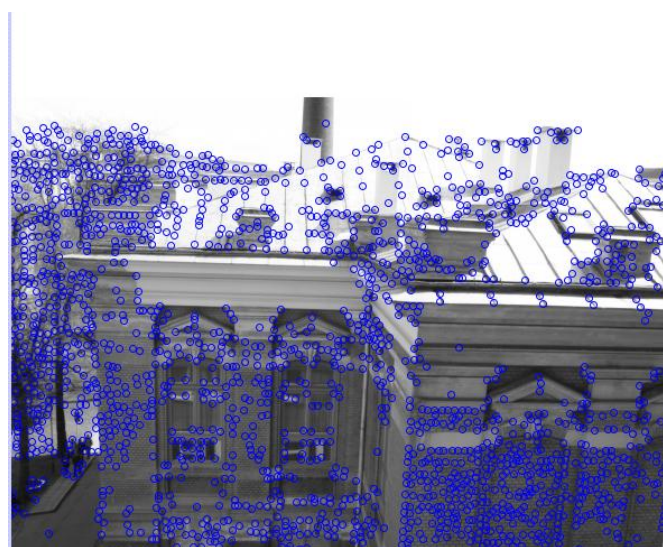


# Corners detection problems

**Moravec**

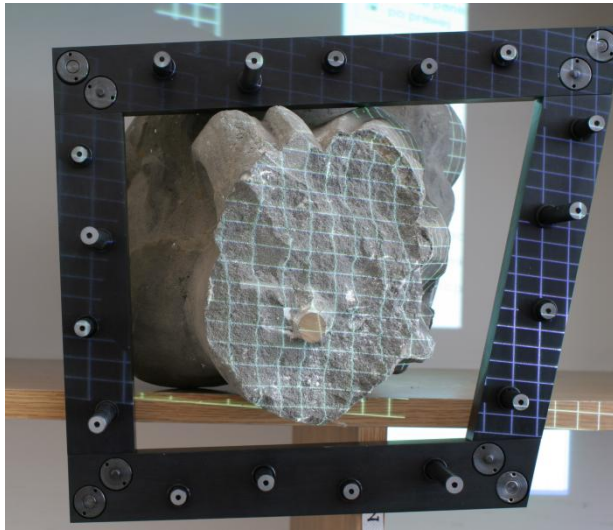


**Harris**





# Symbols examples

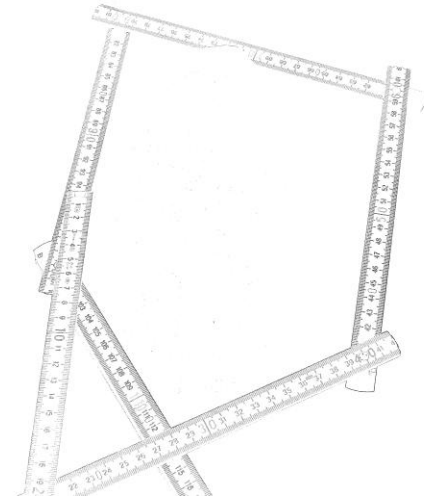


# Symbols detection

**Original image**



**Edge detection**



# Feature-based matching methods

- Relaxation
- Dynamic programming
- Relational matching
- Matching in image pyramids

# Proposed methods

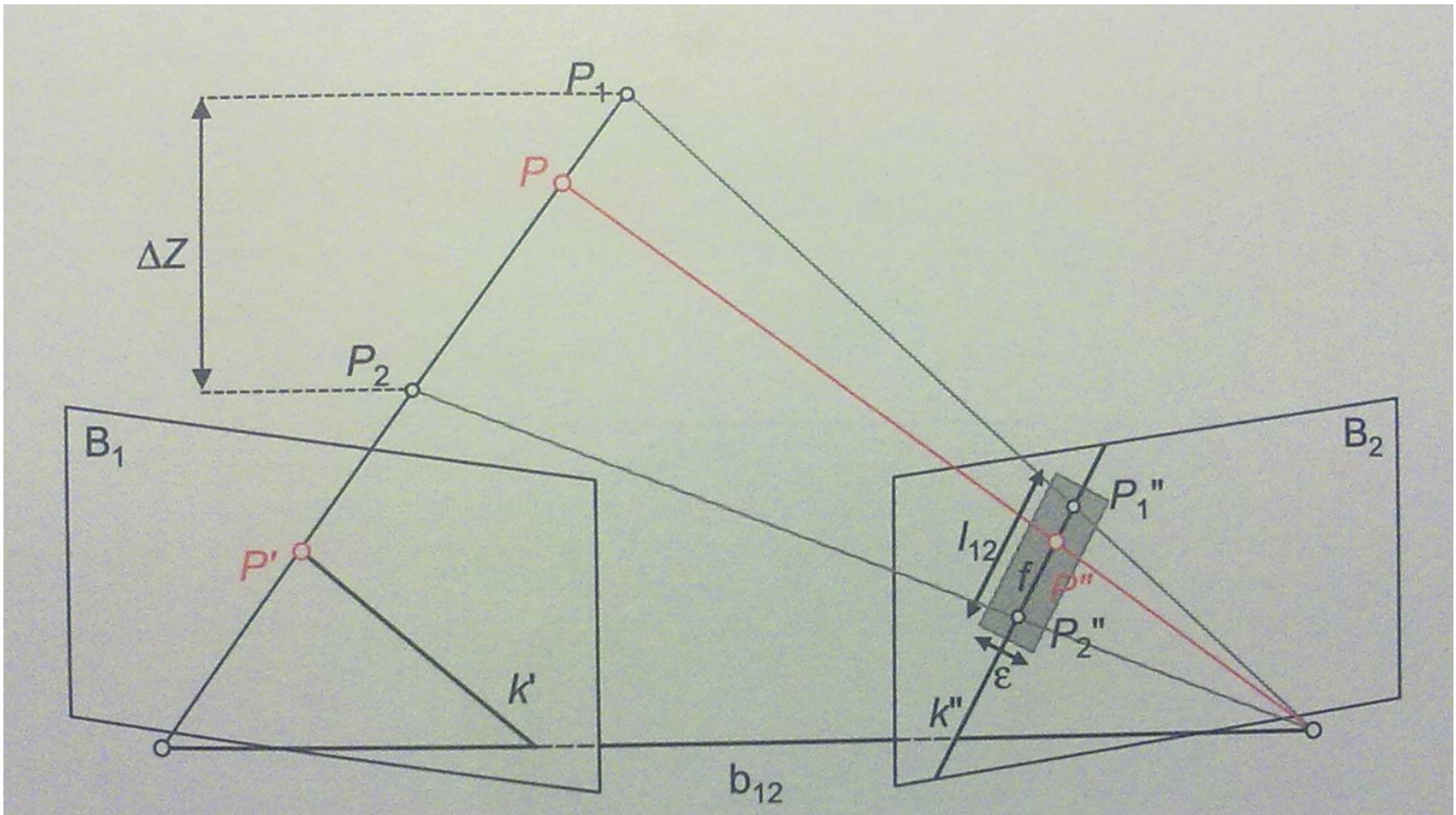
- Regression task
  - $(x_L, y_L)$  as a function of  $((x_R, y_R), F)$
- Classification task
  - Two class paired and non-paired
  - Features described as  $|F_R - F_L|$
- Receiver Operating Characteristic curves

# Matching problems

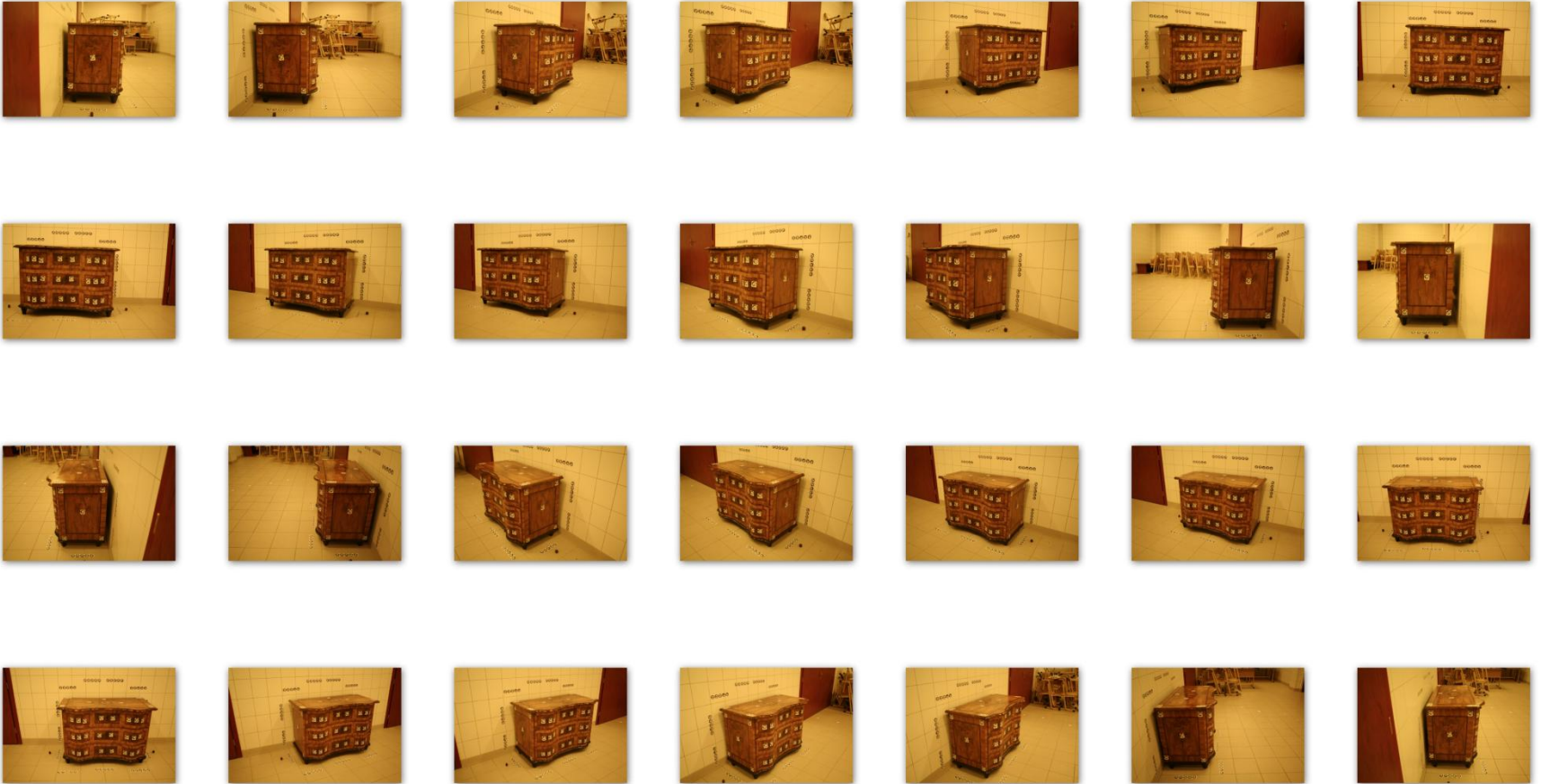
Matching point  $i$  on image  $j$  with point on image  $k$

- Occlusion
  - Point  $P_{ij}$  does not have a homologous partner point  $P_{ik}$
- Ambiguity
  - Several candidates  $P_{ik}$  for image point  $P_{ij}$
- Unstable solutions
  - Noises

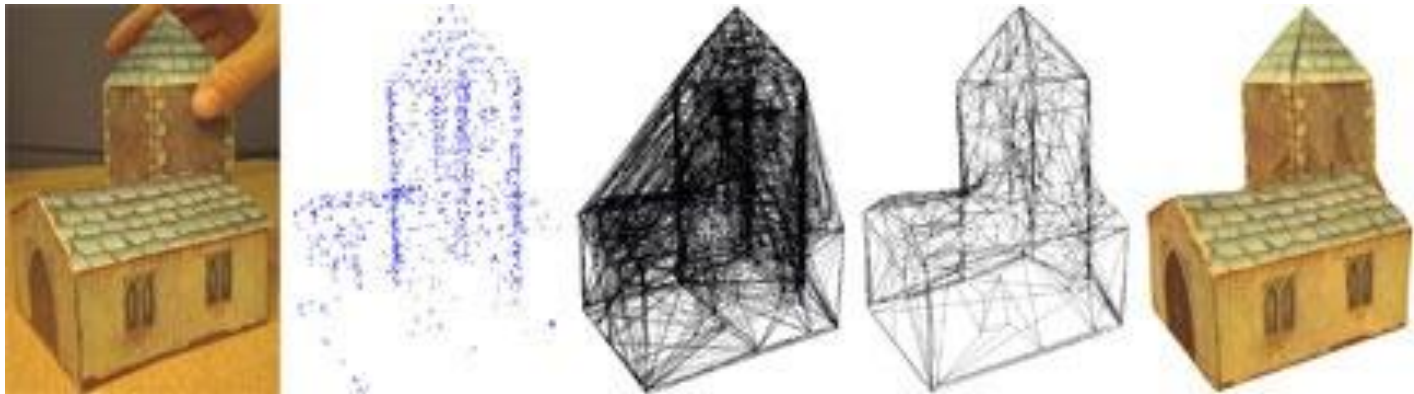
# Matching in image pairs



# Multi view geometry task



# ProForma Example



[Probabilistic Feature-based On-line Rapid Model Acquisition](#)



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- Goshtasby, Ardeshir
  - *2-D and 3-D image registration for medical, remote sensing, and industrial applications*, Wiley 2005
- Hartley, Richard & Zisserman, Andrew
  - *Multiple view geometry in computer vision*, Cambridge 2003
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