Lecture 8 Finding Shapes

COMP3204 & COMP6223 Computer Vision

How can we group points to find shapes?

Mark Nixon & Alberto Aguado
Third Edition
Feature Extraction & Image Processing for Computer Vision

Book
pp
222-235;
243-249

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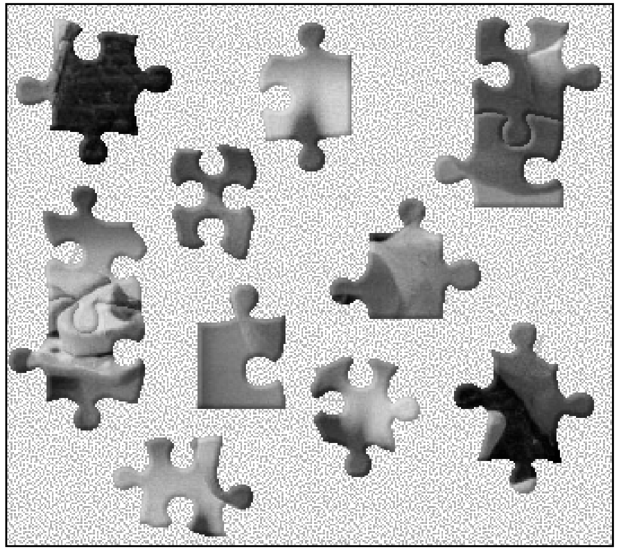
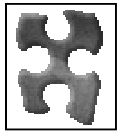
Template Matching

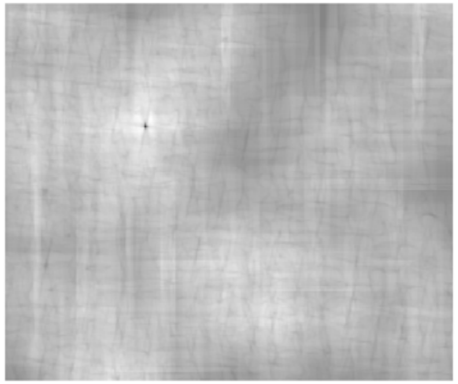
- Intuitively simple
- Correlation and convolution
- Implementation via Fourier
- Relationship with matched filter, viz: optimality



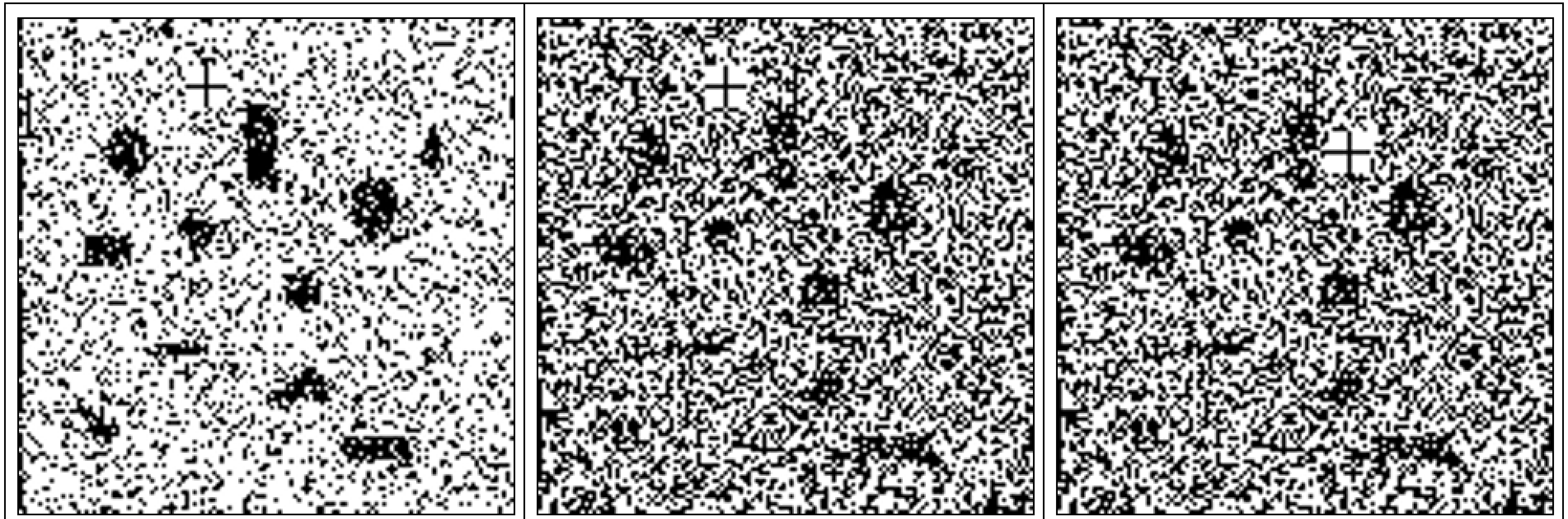
image



template



accumulator space

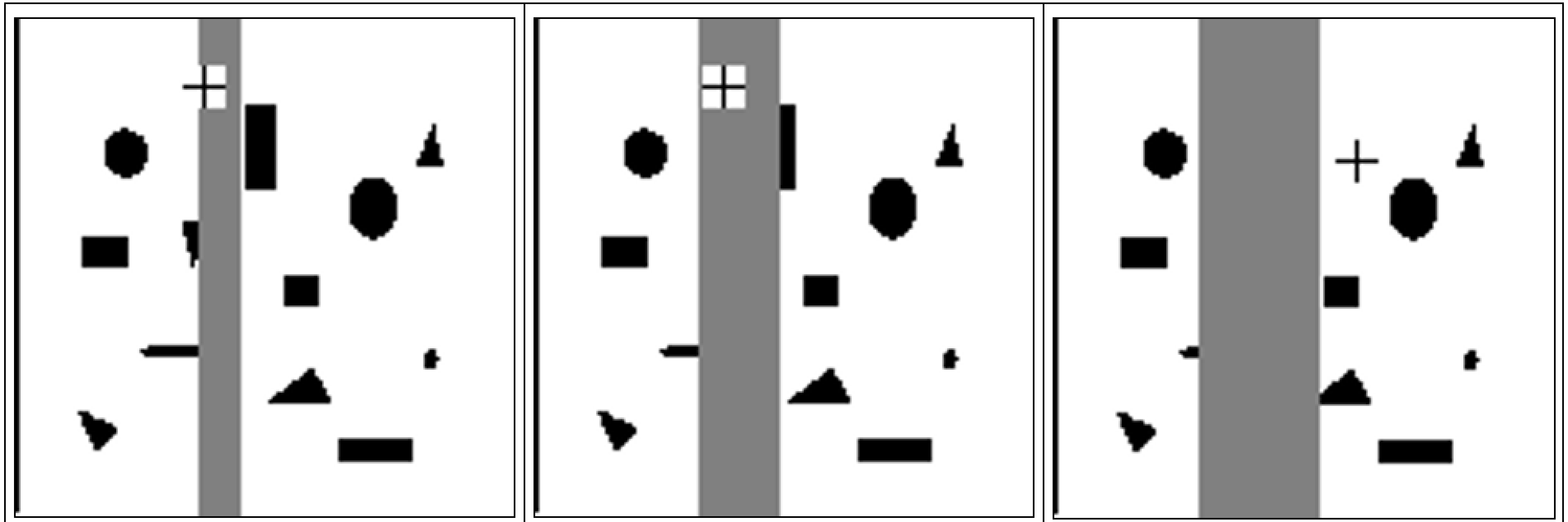


(a) extraction (of the black rectangle) in some noise

(b) extraction in a lot of noise

(c) extraction in too much noise (failed)

Template Matching in Noisy Images



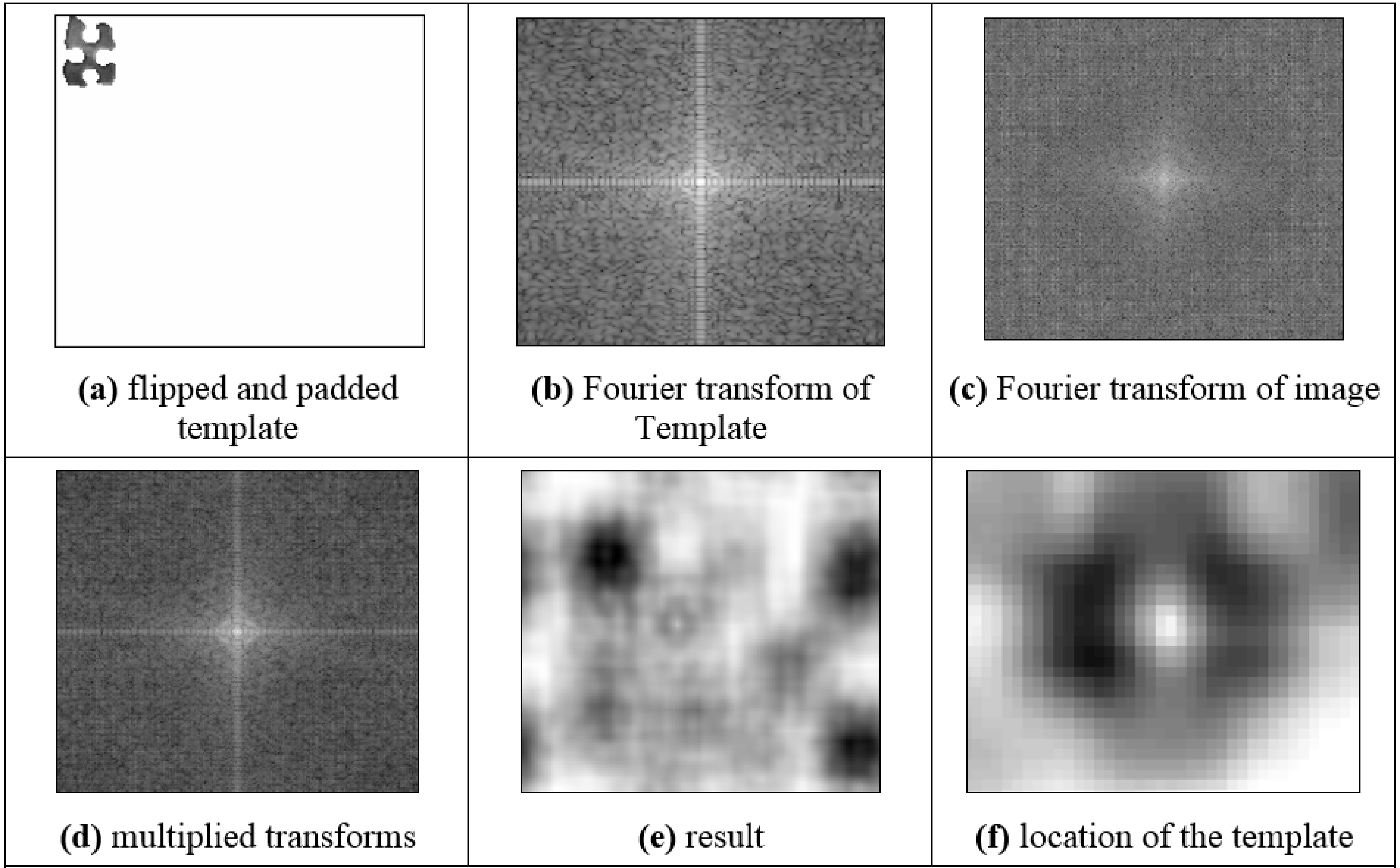
(a) extraction (of the black rectangle) in no occlusion

(b) extraction in some occlusion

(c) extraction in complete occlusion (failed)

Template Matching in Occluded Images

Encore, Monsieur Fourier!



(a) flipped and padded template

(b) Fourier transform of Template

(c) Fourier transform of image

(d) multiplied transforms

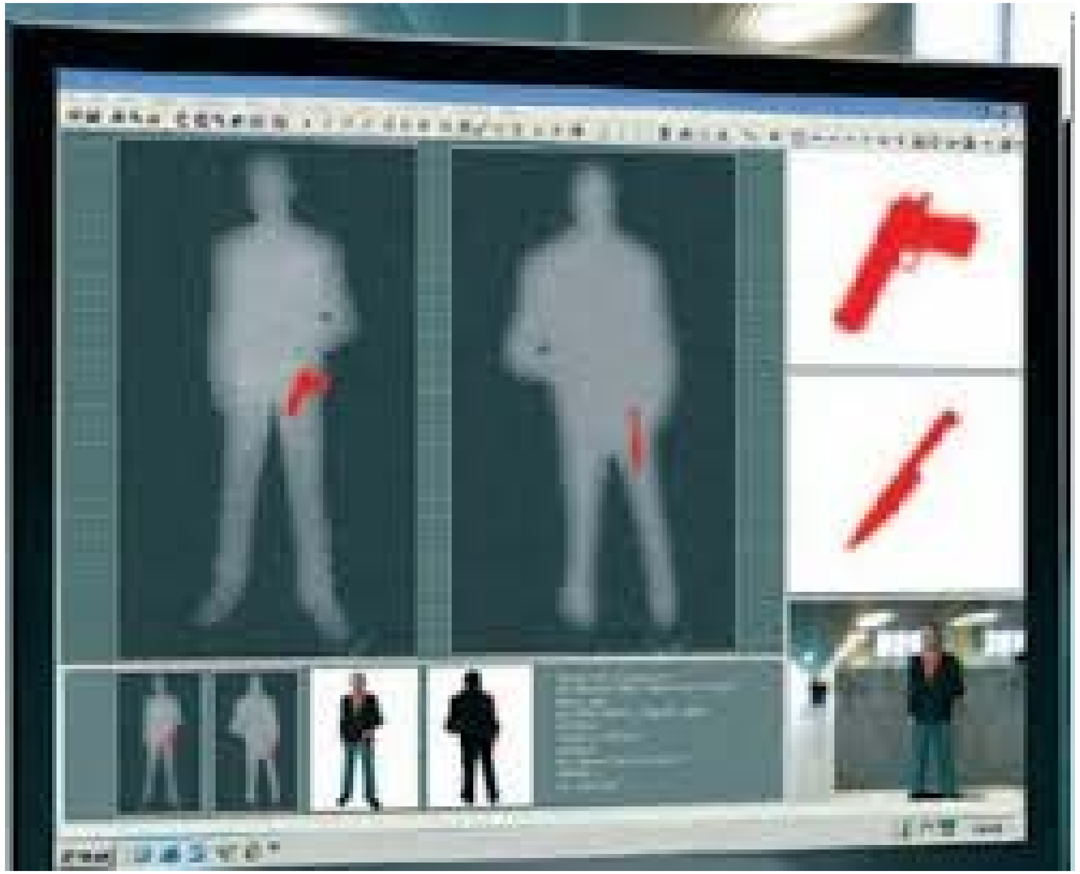
(e) result

(f) location of the template

Template Matching by Fourier Transformation

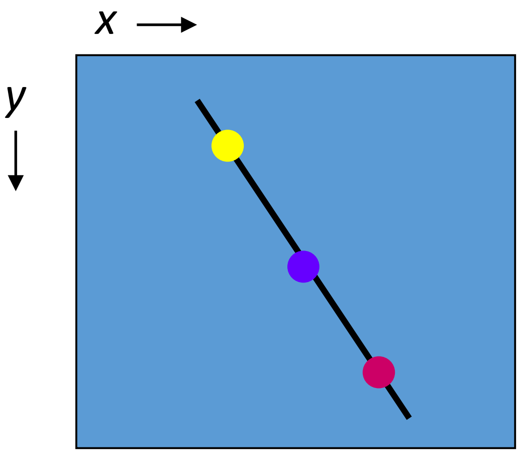
$$\mathbf{P} \otimes \mathbf{T} = F^{-1}\left(F(\mathbf{P}) \times \left(F(\mathbf{T})\right)^{C}\right)$$
$$= \sum_{i \in \mathbf{P}} \sum_{j \in \mathbf{P}} \mathbf{P}_{i,j} \mathbf{T}_{i+n,\, j+m}$$

Applying template matching

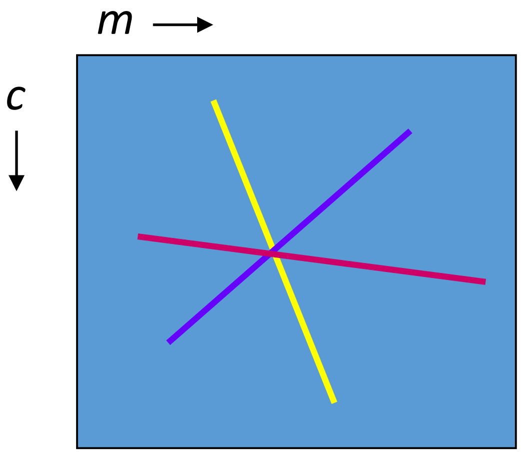


Hough Transform

- Performance equivalent to template matching, but faster
- A line is points *x*,*y* gradient *m* intercept *c* $y = m \times x + c$
- and is points *m*,*c* gradient -*x* intercept *y* $c = -x \times m + y$

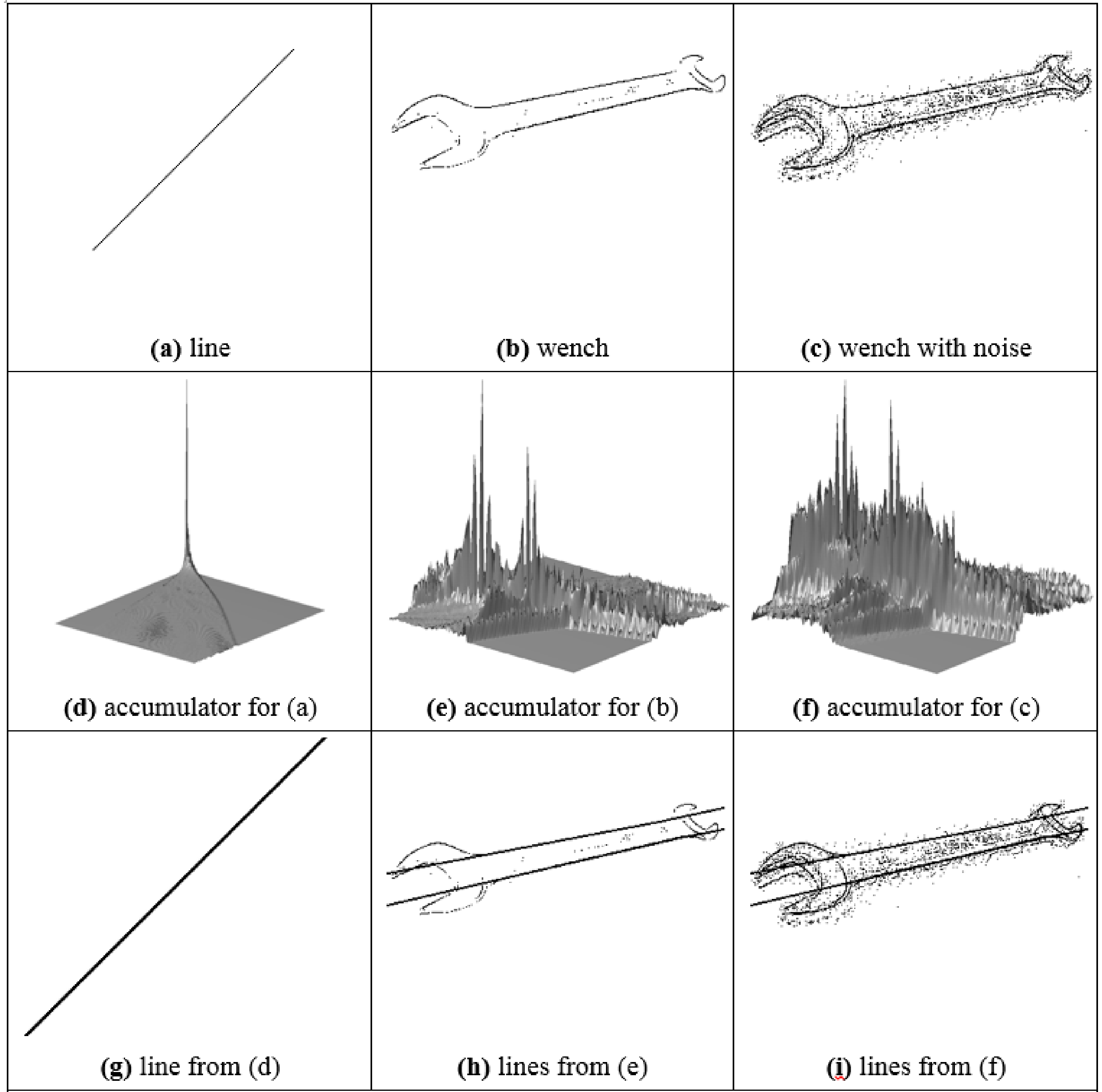


image



accumulator space

- In maths it's the principle of duality



(a) line

(b) wench

(c) wench with noise

(d) accumulator for (a)

(e) accumulator for (b)

(f) accumulator for (c)

(g) line from (d)

(h) lines from (e)

(i) lines from (f)

Applying the Hough Transform for Lines

Hough Transform for Lines … problems

- *m,c* tend to infinity
- Change the parameterisation
- Use foot of normal $\rho = x\cos\theta + y\sin\theta$
- Gives polar HT for lines

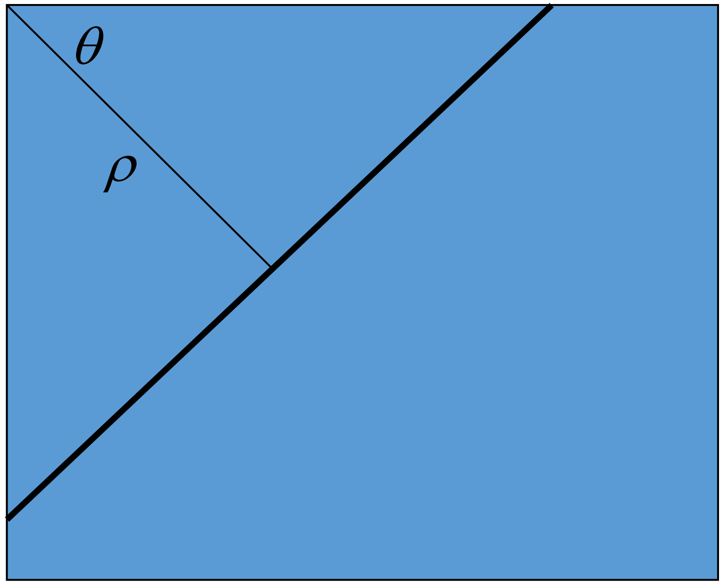
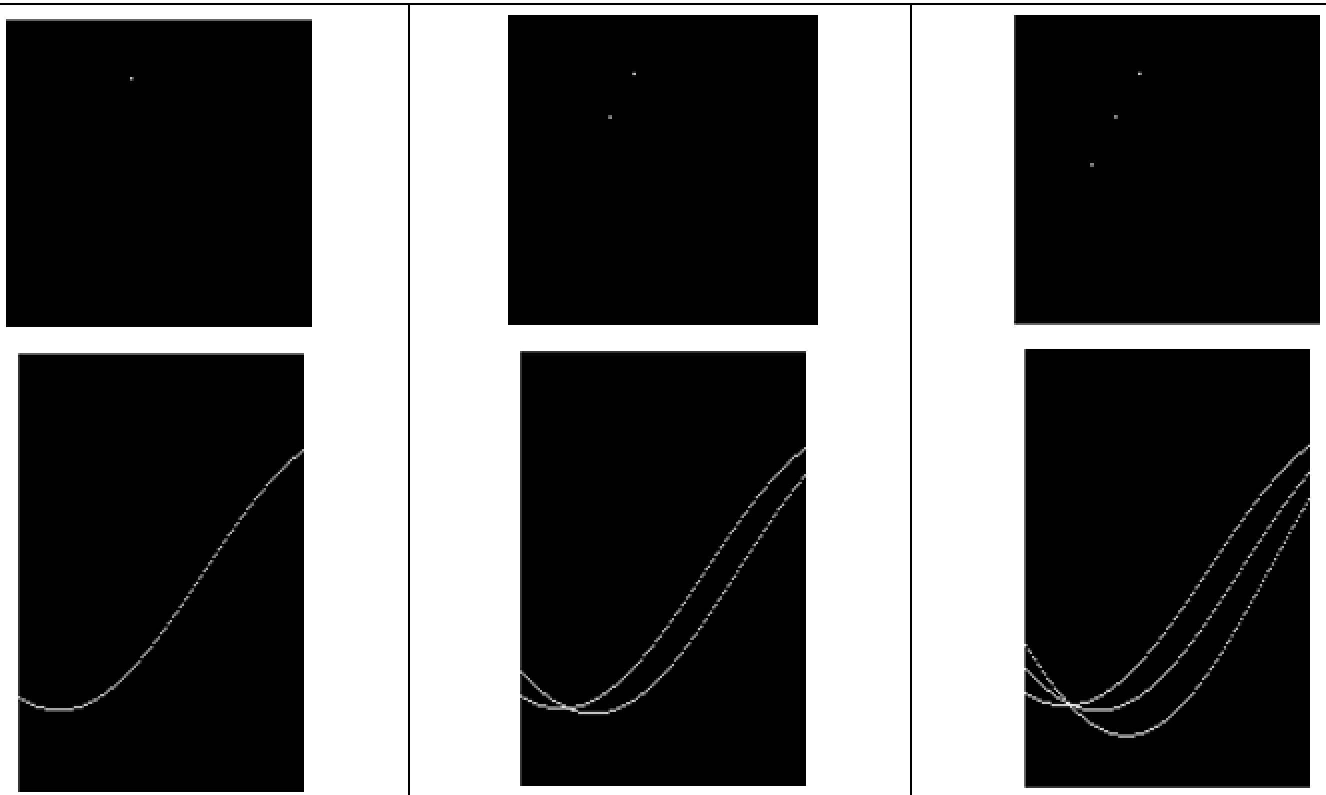


Image containing line



(a) for one point

(b) for two points

(c) for three points

Images and the Accumulator Space of the Polar Hough Transform

Applying the Hough transform