Lecture 8 Finding Shapes

COMP3204 & COMP6223 Computer Vision

How can we group points to find shapes?

Book pp 222-235; 243-249

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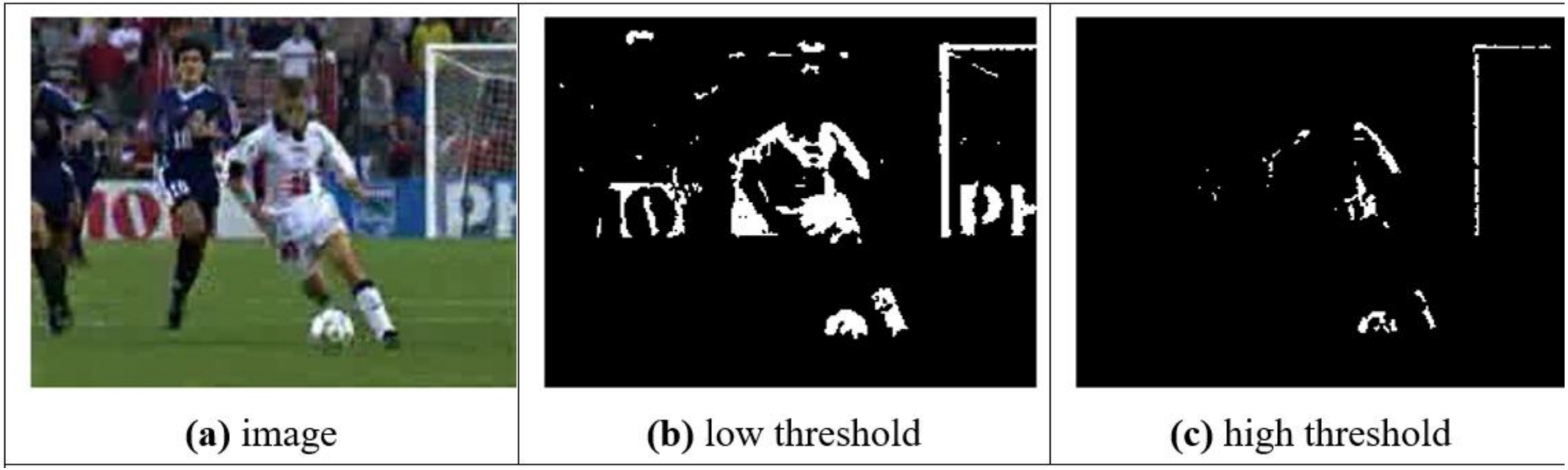
Feature extraction by thresholding

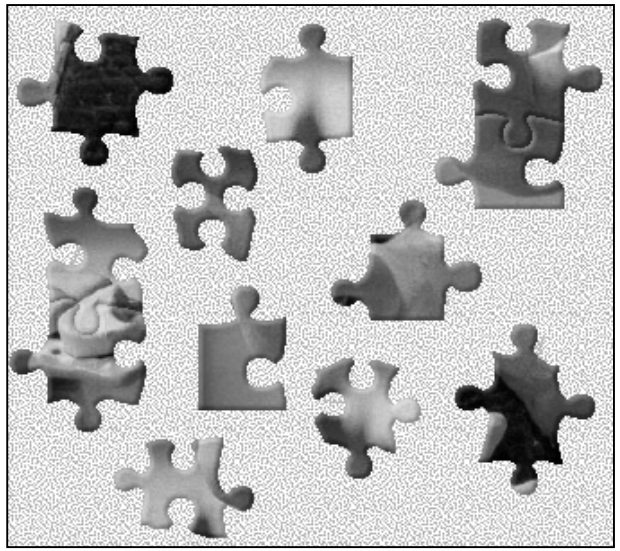


(a) image | **(b)** low threshold | **(c)** high threshold

- Conclusion: we need shape!

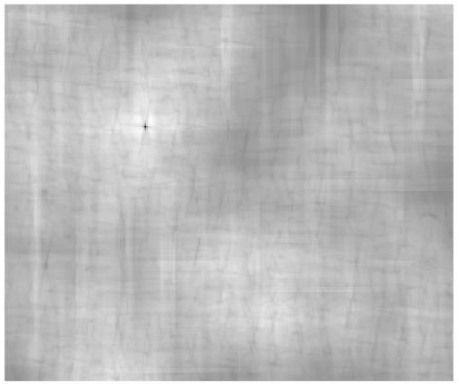
Template Matching

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



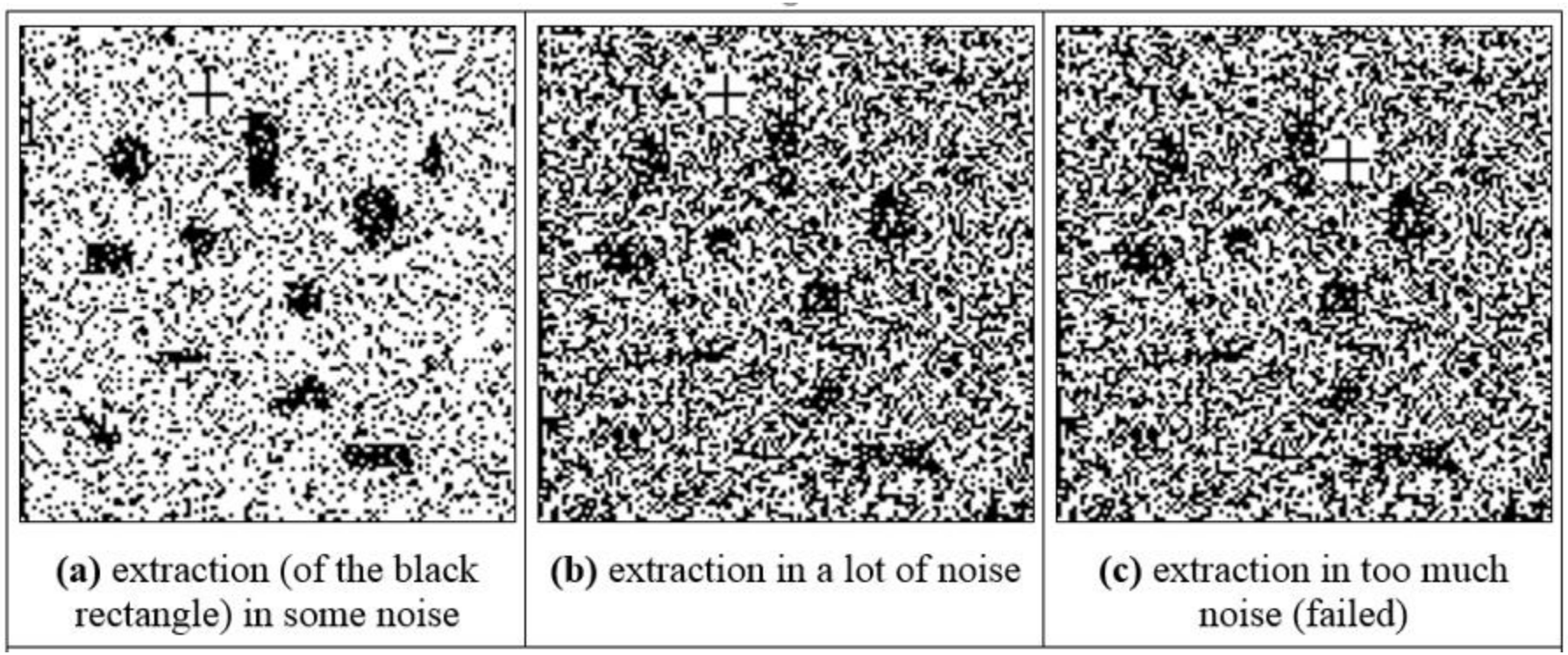
image

template



accumulator space

Template matching in noisy images

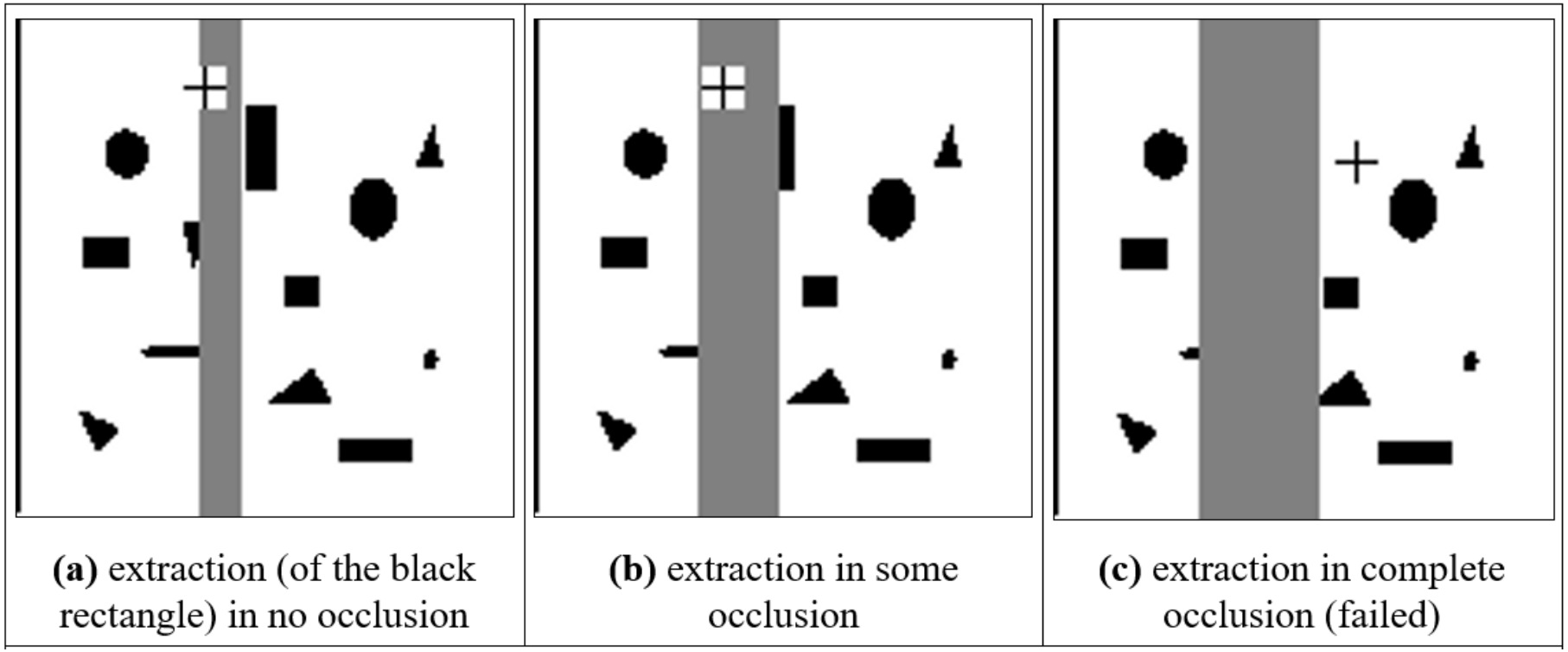


(a) extraction (of the black rectangle) in some noise

(b) extraction in a lot of noise

(c) extraction in too much noise (failed)

Template matching in occluded images

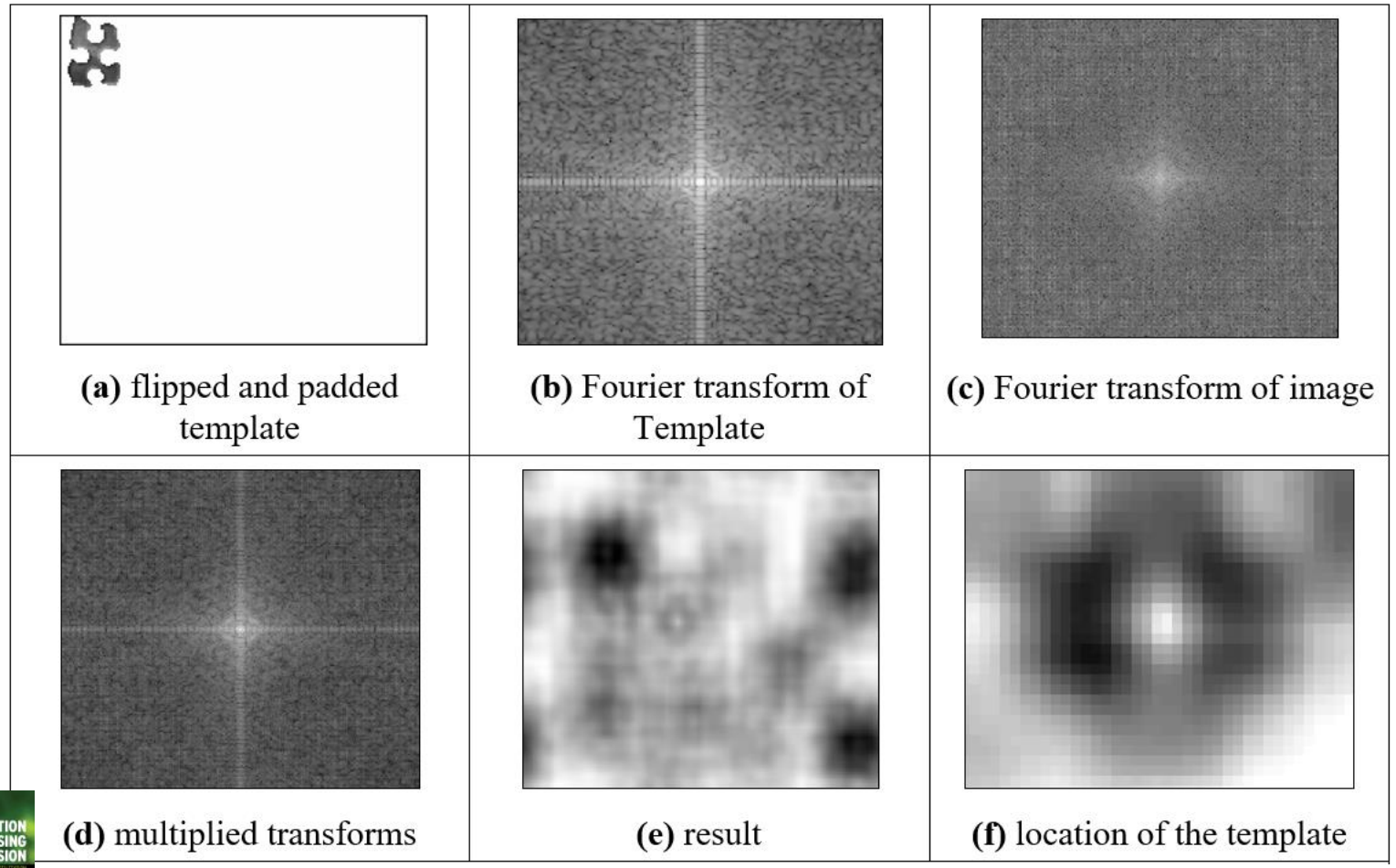


(a) extraction (of the black rectangle) in no occlusion

(b) extraction in some occlusion

(c) extraction in complete occlusion (failed)

Encore, Monsieur Fourier!



(a) flipped and padded template

(b) Fourier transform of Template

(c) Fourier transform of image

(d) multiplied transforms

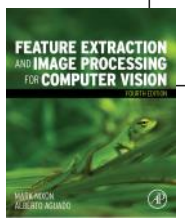
(e) result

(f) location of the template

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

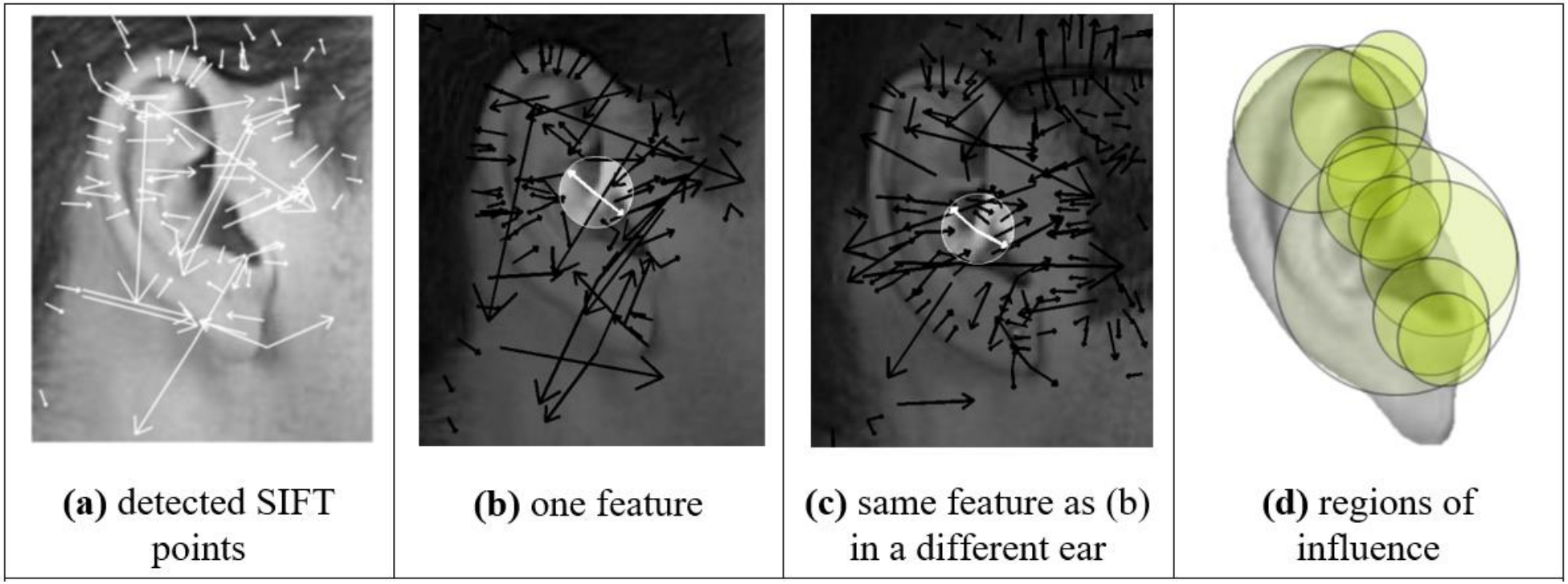
No sliding of templates here;

cost is Fourier Transform plus multiplication



Applying template matching

Applying SIFT in ear biometrics



(a) detected SIFT points

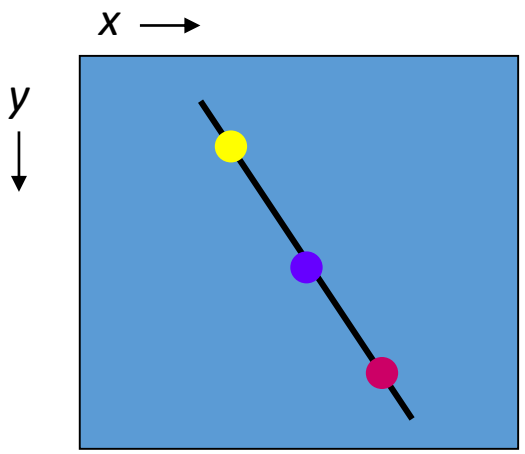
(b) one feature

(c) same feature as (b) in a different ear

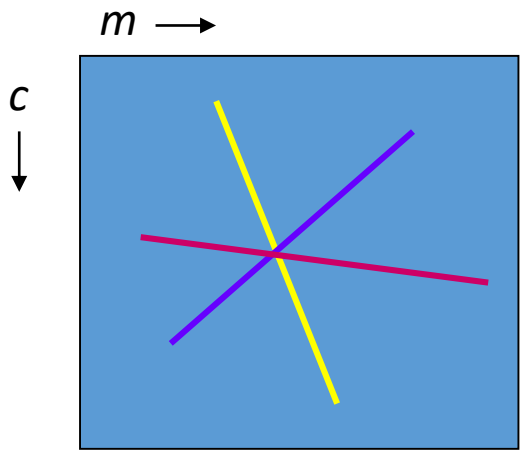
(d) regions of influence

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* $c = -x \times m + y$



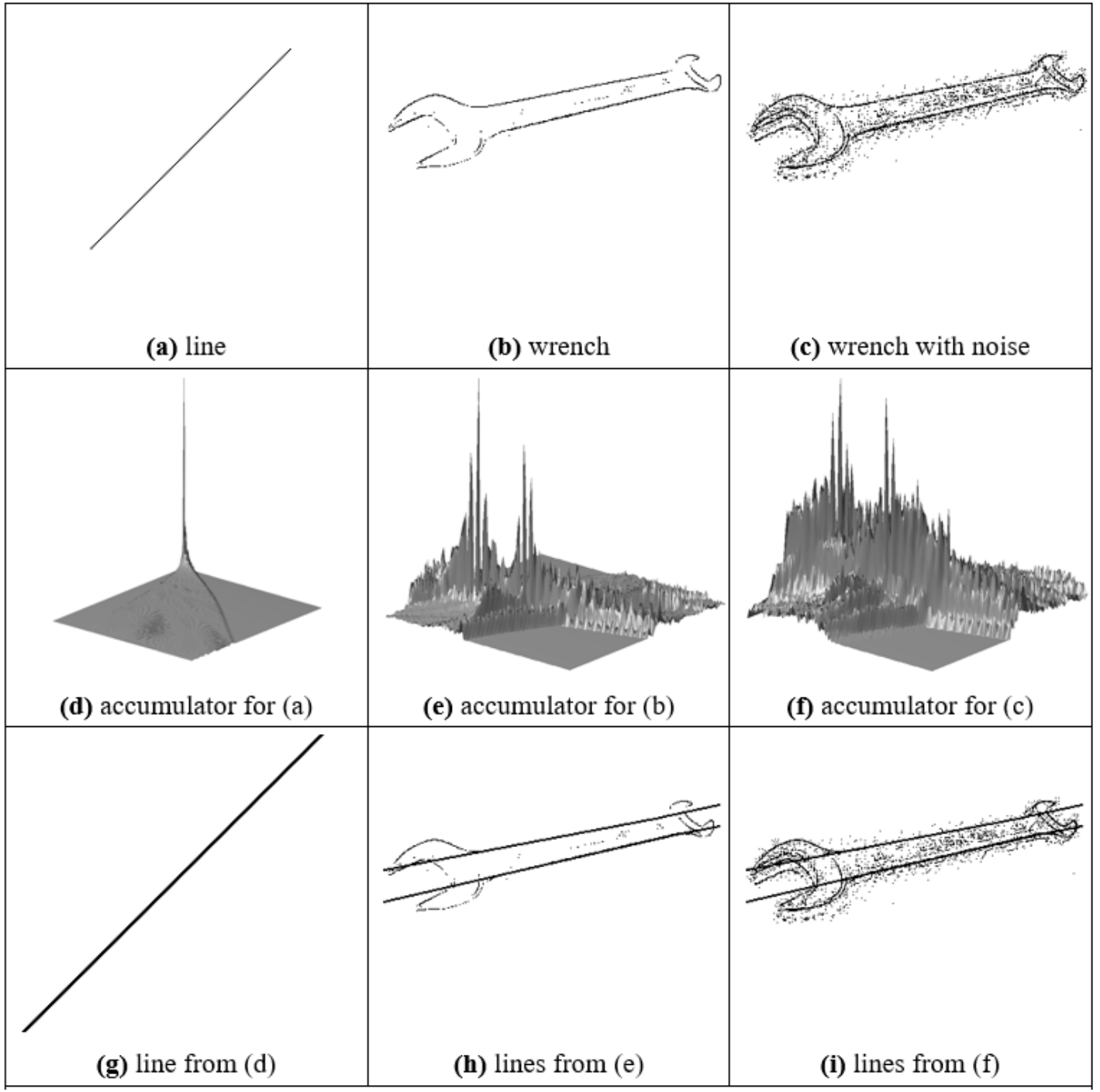
image



accumulator space

- In maths it's the principle of duality

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

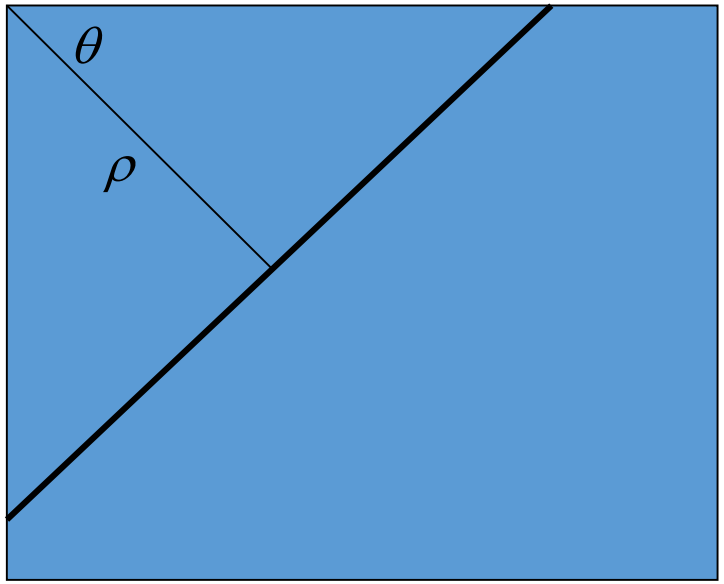
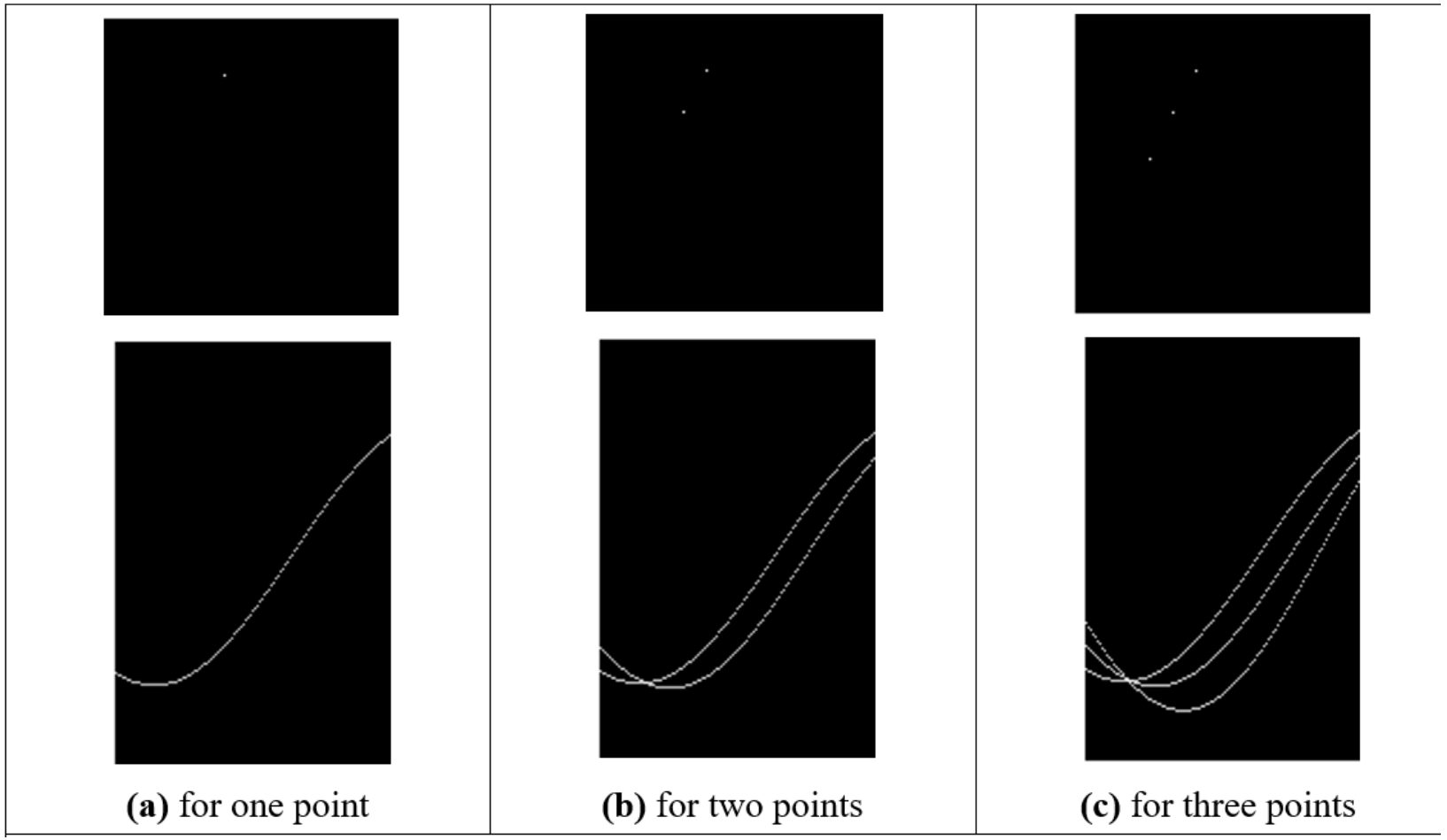


Image containing line

Images and the accumulator space of the polar Hough transform



(a) for one point **(b)** for two points **(c)** for three points

Applying the Hough transform