EE4704 Image Processing and Analysis

Semester 1, 2020/21

Tutorial Set F

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1. Compactness is defined as

$$\gamma = \frac{(\text{perimeter})^2}{4\pi \times \text{area}}.$$

(a) For the rectangle shown in Figure 1(a), express γ as a function of k. Sketch γ *vs* k, and show that γ is minimum when the sides of the rectangle are equal, i.e., it is a square.

(b) Consider an ellipse with major diameter $2a$ and minor diameter $2b$ (Figure 1(b)). What is the eccentricity ϵ of the ellipse? Sketch γ *vs* ϵ and show that γ is minimum when $\epsilon = 1$, i.e., when the ellipse is a circle.
Note: For an elllipse, the area is πab and the perimeter is approximately $\pi\sqrt{2(a^2+b^2)}$.)

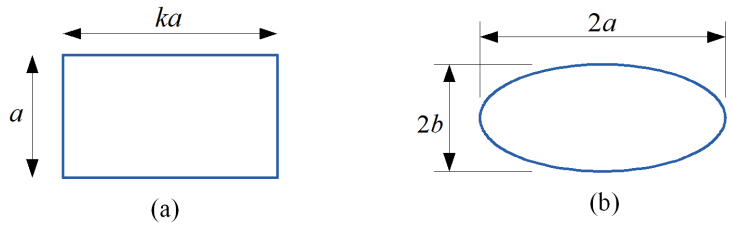


Figure 1

2. A 512×512 image (Figure 2) contains several objects. Describe, step by step, a procedure that can be used to obtain the centroid of each object.

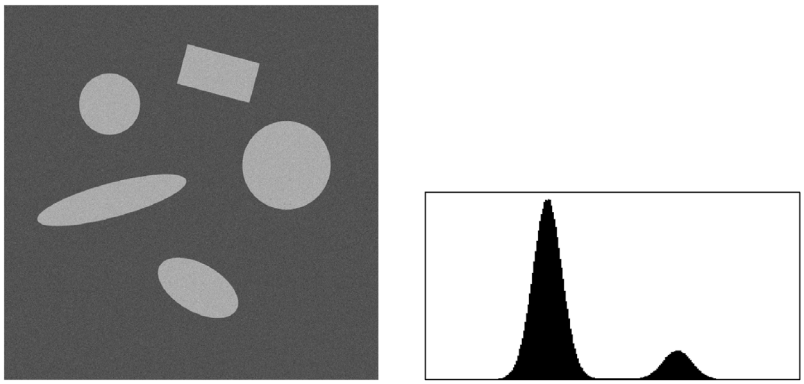


Figure 2

3. (a) Obtain an expression for ϕ_1 for a rectangle of size $a \times b$ (Figure 3(a)).

   (b) Calculate the normalised central moment η_{11} and the first invariant moment ϕ_1 for the L-shaped object shown in the Figure 3(b), where $f(x, y)$ has value 1 for the object region and 0 elsewhere.

   (c) After digitisation, the image is as shown in Figure 3(c). Calculate η_{11} and ϕ_1.

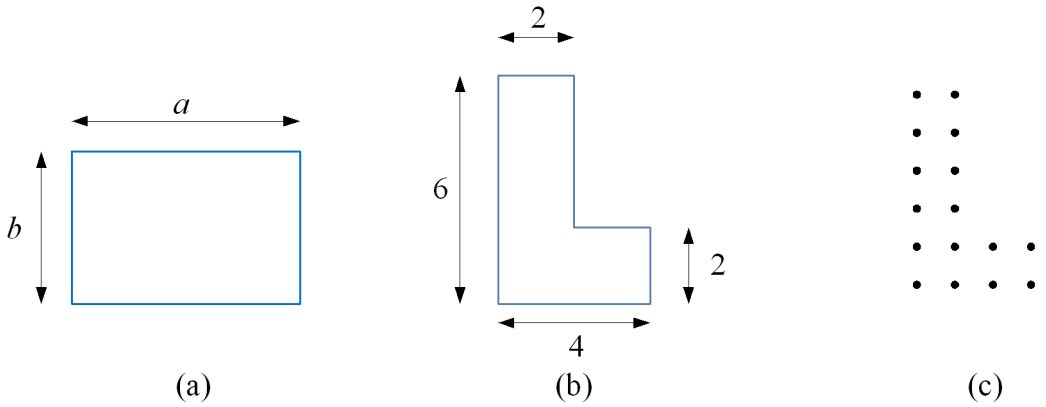


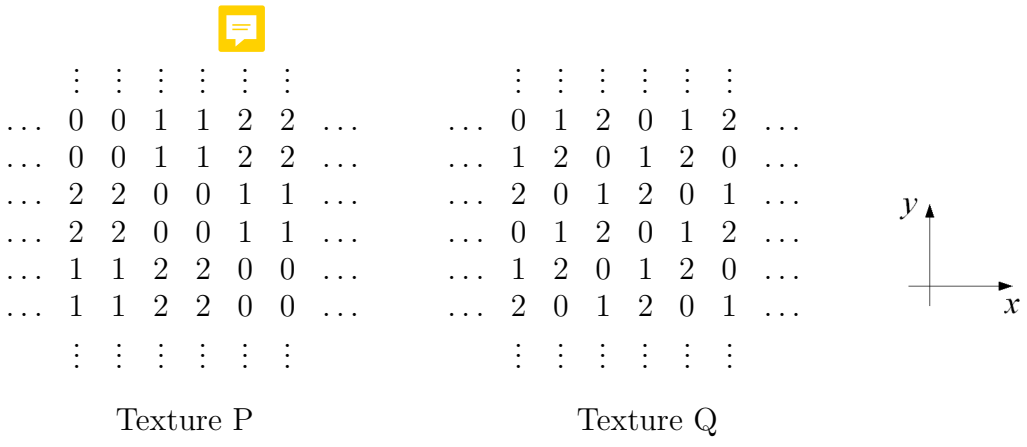
Figure 3
(x axis points to the right, y axis points up)

4. The basic patterns of two textures, P and Q, are shown in Figure 4.

   (a) Obtain the GLCMs using the displacements $\delta_1 = (0, 1)$ and $\delta_2 = (0, 2)$ for texture P, and $\delta_3 = (-1, 1)$ and $\delta_4 = (1, 1)$ for texture Q. For each GLCM, compute the descriptor "element-difference moment of order 2":

$$D = \sum_i \sum_j (i - j)^2 c_{ij}$$

   (b) Explain how local property statistics obtained using the difference operator $f(x + \Delta x, y) - f(x, y)$ may be used to differentiate between the two textures.



Texture P Texture Q

Figure 4