EE3206/EE3206E INTRODUCTION TO COMPUTER VISION AND IMAGE PROCESSING

Semester 1, 2013/2014

Tutorial Set F

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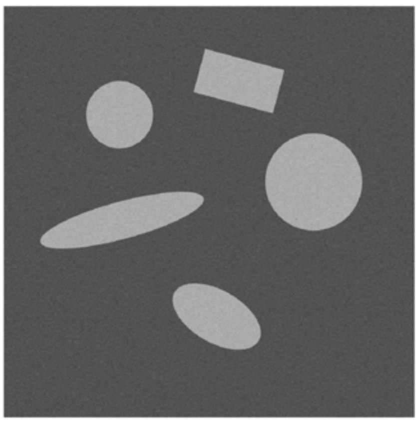
1. Consider the descriptor

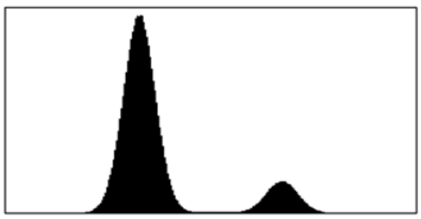
$$\text{compactness} = \frac{(\text{perimeter})^2}{4\pi \times \text{area}}.$$

   (a) Prove that compactness is always greater for a rectangle than for a square.

   (b) Consider an ellipse with major diameter $2a$ and minor diameter $2b$. Show that compactness increases as the eccentricity ϵ increases ($\epsilon \geq 1$). (For an elllipse, the area is πab and the perimeter is approximately $\pi\sqrt{2(a^2+b^2)}$.)

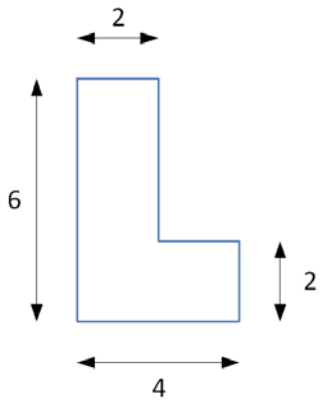
2. A 512×512 image contains several objects. Describe, step by step, a procedure that can be used to obtain the centroid of each object.

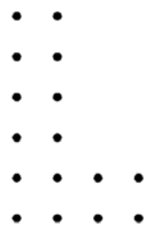




3. **(a)** Calculate the normalised central moment η_{11} and the first invariant moment ϕ_1 for the L-shaped object shown in the first figure, where $f(x, y)$ has value 1 for the object region and 0 elsewhere.

   (b) After digitisation, the image is as shown in the second figure. Determine η_{11} and ϕ_1.





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

   (a) Obtain the GLCMs for the images 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.

$$\begin{array}{cccccccc}
 & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \\
\cdots & 0 & 0 & 1 & 1 & 2 & 2 & \cdots \\
\cdots & 0 & 0 & 1 & 1 & 2 & 2 & \cdots \\
\cdots & 2 & 2 & 0 & 0 & 1 & 1 & \cdots \\
\cdots & 2 & 2 & 0 & 0 & 1 & 1 & \cdots \\
\cdots & 1 & 1 & 2 & 2 & 0 & 0 & \cdots \\
\cdots & 1 & 1 & 2 & 2 & 0 & 0 & \cdots \\
 & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots &
\end{array}$$

Texture P

$$\begin{array}{cccccccc}
 & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \\
\cdots & 0 & 1 & 2 & 0 & 1 & 2 & \cdots \\
\cdots & 1 & 2 & 0 & 1 & 2 & 0 & \cdots \\
\cdots & 2 & 0 & 1 & 2 & 0 & 1 & \cdots \\
\cdots & 0 & 1 & 2 & 0 & 1 & 2 & \cdots \\
\cdots & 1 & 2 & 0 & 1 & 2 & 0 & \cdots \\
\cdots & 2 & 0 & 1 & 2 & 0 & 1 & \cdots \\
 & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots &
\end{array}$$

Texture Q