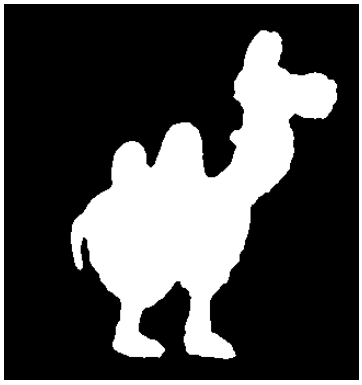
Tutorial: Image Characterization

Note

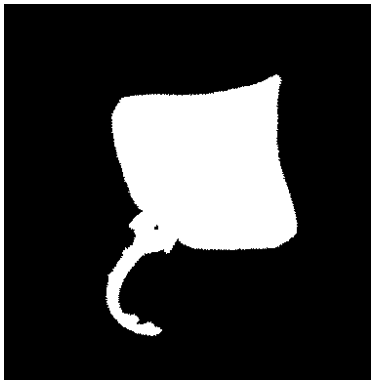
This tutorial aims to characterize objects by geometrical and morphometrical measurements.

The different processes will be applied on synthetic images as well as images from the Kimia database [1, 2]:

(a) Bat.



(b) Camel.



(c) Ray.

1 Perimeters

We are going to calculate the perimeter using the Crofton formula. This formula consists in integrating the intercept number of the object with lines of various orientation and positions. Its expression in the 2-D planar case is given by:

$$P(X) = \pi \int \chi(X \cap L) dL$$

where the Euler-poincaré characteristic χ is equal to the number of connected components of the intersection of X with a line L.
In the discrete case, the Crofton formula can be estimated by considering the intercept numbers for the horizontal i_0, vertical $i_{\pi/2}$ and diagonal orientations $i_{\pi/4}$ and $i_{3\pi/4}$ as:

$$P(X) = \pi \times \frac{1}{4}\left(i_0 + \frac{1}{\sqrt{2}} i_{\pi/4} + i_{\pi/2} + \frac{1}{\sqrt{2}} i_{3\pi/4}\right)$$

1. Calculate the intercept number of a binary object from the Kimia database with lines oriented in the following four directions: $0, \pi/4, \pi/2, 3\pi/4$.
2. Deduce the value of the Crofton perimeter.
3. Compare the result with the perimeter given by the Matlab function bwperim.

2 Feret Diameter

The Feret diameter (a.k.a. the caliper diameter) is the length of the projection of an object in one specified direction Fig.1.

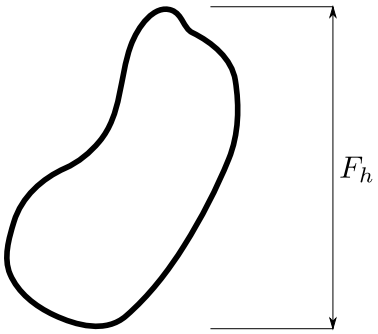


Figure 1: Feret diameter of the object in horizontal direction.

1. Calculate the projections in different directions of a binary object from the Kimia database.
2. Deduce the minimum, maximum and mean value of the Feret diameters.

3 Circularity

We want to know if the object X is similar to a disk. For that, we define the following measurement (circularity criterion):

$$circ(X) = \frac{4\pi A(X)}{P(X)^2}$$

where $A(X)$ and $P(X)$ denote the area and perimeter of the object X.

1. Show that the circularity of a disc is equal to 1.
2. Generate an array representing an object as a discrete disc. The useful functions are meshgrid and numpy.meshgrid.
3. Calculate its circularity and comment the results.

4 Convexity

We want to know if the object X is convex. For that, we define the following measurement:

$$conv(X) = \frac{A(X)}{A(CH(X))}$$

where $CH(X)$ denotes the filled convex hull of the object X.

1. Compute the convex hull of a pattern from the Kimia database using the Matlab function convhull.
2. Evaluate the area of the filled convex hull using the Matlab function poly2mask.
3. Deduce the convexity of the pattern.

References

[1] http://vision.lems.brown.edu/content/available-software-and-databases. 1

[2] Daniel Sharvit, Jacky Chan, Huseyin Tek, and Benjamin B Kimia. Symmetry-based indexing of image databases. In *Content-Based Access of Image and Video Libraries, 1998. Proceedings. IEEE Workshop on*, pages 56–62. IEEE, 1998. 1