Exercise Multimedia Technology
WS 2003/2004

Sheet 10 (January 16th, 2004)

Exercise 10.1 K-means

The following file contains 4D vectors forming two distinct clusters.

http://www.informatik.uni-mannheim.de/informatik/pi4/data/data_kmeans.asc.gz

Write a small script or program to find out the centers of the clusters.

- What kind of trivial solution do you encounter?

  It can happen easily that one cluster center gets all points while the other center gets nothing at all. The first center will not change anymore since it has gathered all the points and the second will not change either. So an 'empty' cluster should alert you.

- What precautions do you have to take to avoid them?

  Start at random locations for each cluster. If you encounter the situation described above repeat the process.

- Where is the center of each cluster?

  Center 1: (4256.99, 3250.18, 2256.83, 1252.95)

  Center 2: (1402.46, 2398.86, 3408.95, 4407.38)

Sample solution: http://www.informatik.uni-mannheim.de/informatik/pi4/data/kmeans.tgz

Exercise 10.2 The Hough-Transform

(1) What does a single point in the spatial domain look like in the Hough-domain? Given only the Hough-representation of the point, is it possible to find the point in the spatial domain? How could that work in theory and practice?

The single point P in the spatial domain maps to a sine shaped curve in the Hough-space. The reason for this is that a point does not define a line. Thus the bundle of all lines going through P has to be considered. The result will be the sine-shaped trajectory. Find the point in the spatial domain by integrating over the sine-curve in the Hough-domain. The integration will yield only one point in the spatial domain since all other points are vanishing. In a practical application you will have to find the pixel with the highest density.

Alternative: Pick two pixels from the curve in the hough domain. The intersection of the corresponding lines is already the result.

(1) What would a medium gray (in-between black and white) point look like in the Hough-space?

Theoretically a spatial medium gray point would be achieved by the same sine-shaped curve as in the case of a black point but the curve would only be half as dense.

(2) Does every image in the spatial domain map to an image in the Hough-domain and vice versa?

Mapping spatial -> hough: See exercise (1). Mapping hough -> spatial: Each hough-point defines a line. Iterate over all hough-points and you will get the spatial representation.

(3) Can a rectangle in the spatial domain be detected in the Hough-domain?

Sure. Simply find the four locations in the hough-space where most sine-curves intersect.

(4) What is the representation of a (spatial) circle in the Hough-space (roughly speaking) and how does that representation change with the radius of the circle?

Starting with a single point in the spatial domain we get the sine-curve. By replacing the point with a circle of growing radius we also get a sine-shaped trajectory which is getting broader according to the radius of the circle.

You may use the applet to answer the questions.

Exercise 10.3 Graph-based edge detection

What happens if we replace the cost function by the following term?

$$c(T) = \sum_{t \in T} 1$$

where T denotes the set of pixels t of a trajectory.

As the cost-function only depends on the number of pixels in T (the trajectory or path) T will be kept as short as possible by the optimization. This could result in a straight line between the starting- and ending points of the trajectory (called A and B on the slides of the lecture).

Depending on the implementation T might also travel along the vertical axis before approaching its other end along the horizontal axis or vice versa. Note that the diagonal line does not map to lower cost values then traveling alongside the axis in the case of the cost-function above.