Edge Based segmentation

- Various edge operators produce primitive edge elements
- Human vision tends to organise the observed scene into meaningful units as a significant step towards image understanding
- Further processing is necessary to group edge elements into structures suited to interpretation
- The goal is to make a coherent one dimensional edge feature from many individual local edge elements

What is segmentation?

> “The goal of segmentation is to partition an image into disjoined regions which correspond to objects or their parts”

T. Pavlidis

What are “objects”?

- Some knowledge has to be incorporated
- Knowledge - implicit or explicit constraints on the likehood of a given grouping
- Domain independent - general physical arguments
- Psychology of human perception
- Domain dependent

Two main approaches to segmentation:

- through extracting boundaries of regions - based on discontinuities

- through extracting regions - based on similarities

The two approaches are equivalent - one representation can be converted into the other.

Representation for segmented image data

Input to a segmentation process is an image

- original grey level image
- intrinsic image (e.g. edge gradient magnitude and gradient direction).

Output of the segmentation process can have several forms:

- an image where a pixel value indicates whether the pixel belongs to edge/region or to the background
- an image where a pixel value is a region label
- a data structure which describes the results of segmentation, for example a linked list of coordinates of the outline of a region.

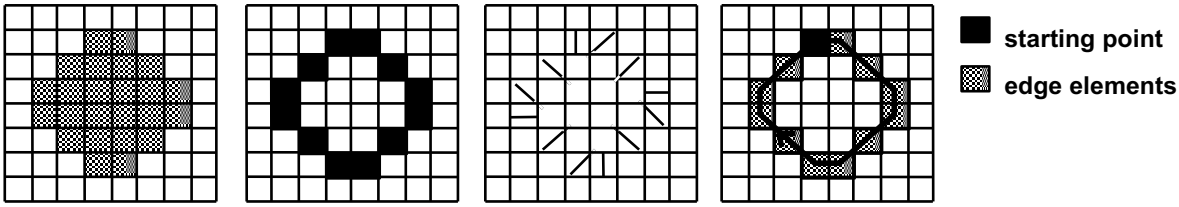
The segmented image is on a higher level of abstraction than an intrinsic image

it contains the beginnings of domain-dependent interpretation

Segmentation via boundary detection and edge linking

Contour following in grey level images

- uses magnitude and gradient images
- if a pixel is on a boundary of an object, subsequent boundary points should be searched in a direction perpendicular to a local gradient direction



original magnitude Gradient direction

Transforms

- Graph searching
- Hough transform

Hough transform

- a shape boundary is known to have a parametric description

- example - straight lines of equation
  (polar coordinates)

$$\rho = x \cos\varphi + y \sin \varphi$$

- all possible straight lines are considered and rated

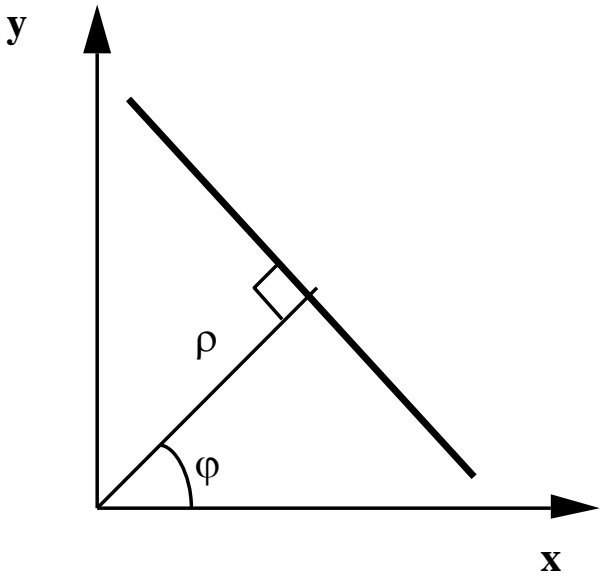
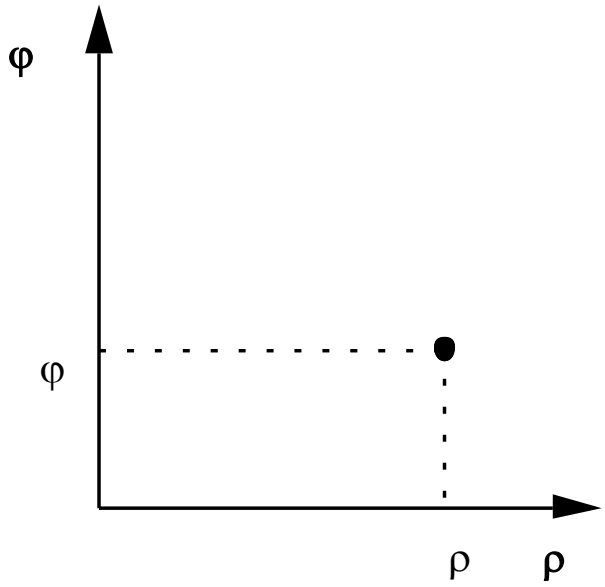


Image space



Hough space

$$\rho = x \cos\varphi + y \sin\varphi$$

Hough transform algorithm

1 quantify parameter space between approximate values of ρ and φ

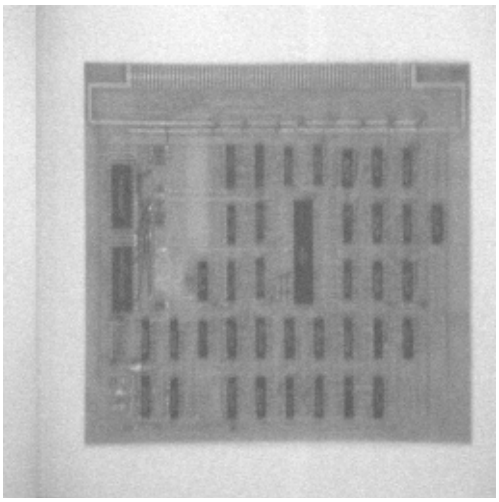
2 set elements of $A(\rho, \varphi)$ to 0

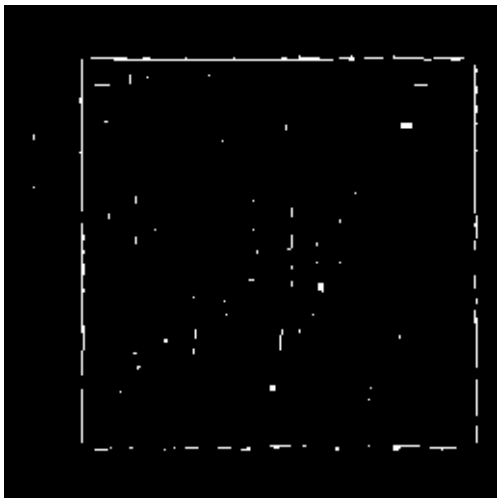
3 for each point (x,y) of a gradient image for which gradient > threshold along a line

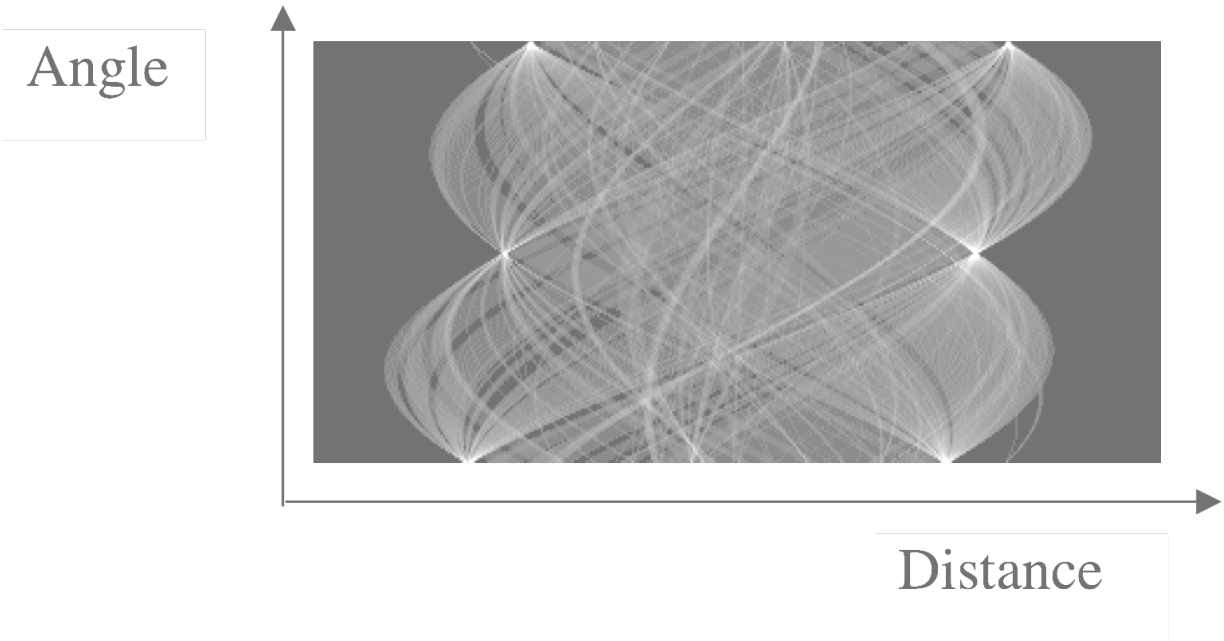
$$A(\rho, \varphi) = A(\rho, \varphi)+1$$

4 Local maxima in A correspond to collinear points in image array

Values at maxima are a measure of the line length






Angle
Distance

Hough transform for conic sections

- circles - 3 parameters (xc, yc, r)
- ellipses - 5 parameters (xc, yc, a, b, φ)
- general conics - 6 parameters