Hough Transform

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The Hough transform

- A method for finding global relationships between pixels.
  Example: We want to find straight lines in an image
  - 1. Apply edge enhancing filter (ex Laplace)
  - 2. Set a threshold for what filter response is considered a true "edge pixel"
  - 3. Extract the pixels that are on a straight line using the Hough transform


original image


edge enhanced image

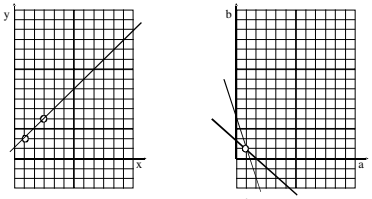

thresholded edge image

The Hough transform

Finding straight lines:

1. consider a pixel in position (xi,yi)
2. equation of a straight line yi=axi+b
3. set b=-axi+ yi and draw this (single) line in "ab-space"
4. consider the next pixel with position (xj,yj) and draw the line b=-axj+ yj "ab-space" (also called parameter space). The points (a',b') where the two lines intersect represent the line y=a'x+b' in "xy-space" which will go through both (xi,yi) and (xj,yj).
5. draw the line in ab-space corresponding to each pixel in xy-space.
6. divide ab-space into accumulator cells and find most common (a', b') which will give the line connecting the largest number of pixels

The Hough transform

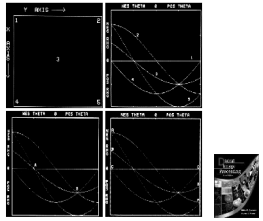


xy-space ab- or parameter space

The Hough transform

- In reality we have a problem with y=ax+b because a reaches infinity for vertical lines.
  Use $x\cos\theta + y\sin\theta = \rho$ instead.
- It is common to use "filters" for finding the intersection: "butterfly filters"
- Different variations of the Hough transform can also be used for finding other shapes of the form g(v,c)=0, v is a vector of coordinates, c is a vector of coefficients.
- Possible to find any kind of simple shape
  ex. circle: $(x-c_1)^2+(y-c_2)^2=c_3^2$ (3D parameter space)

The Hough transform



Conclusions

- The segmentation procedure
  - Pre-processing
  - Segmentation
  - Post-processing
  - ⇒ Like any IP procedure

- There exists NO universal segmentation method
- Evaluation of segmentation performance is important

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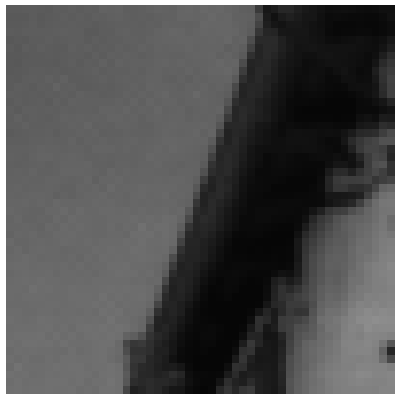

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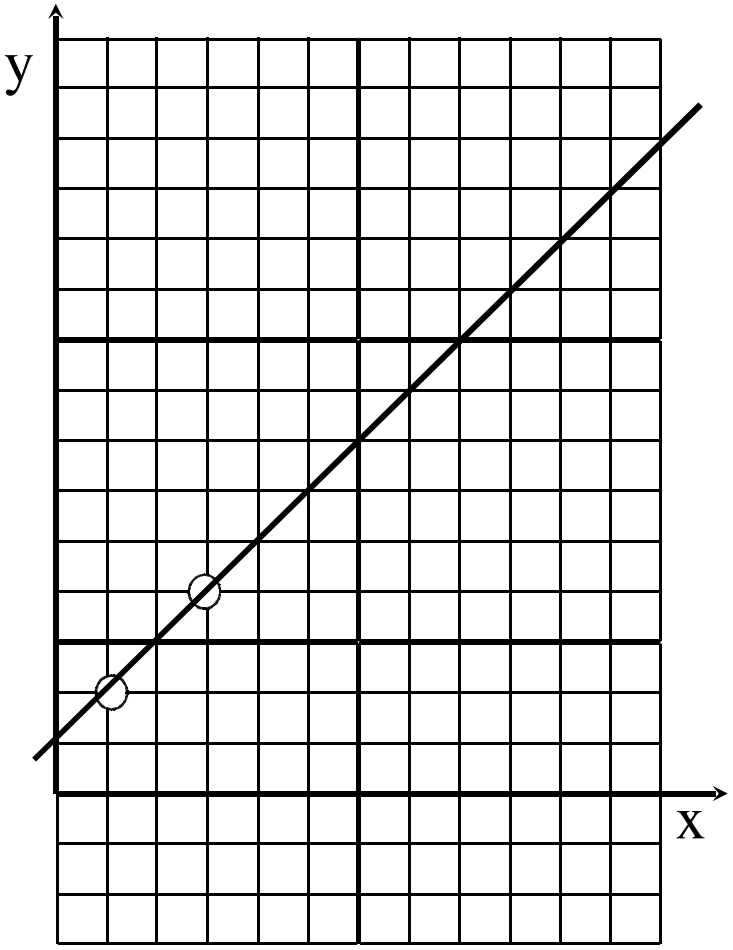
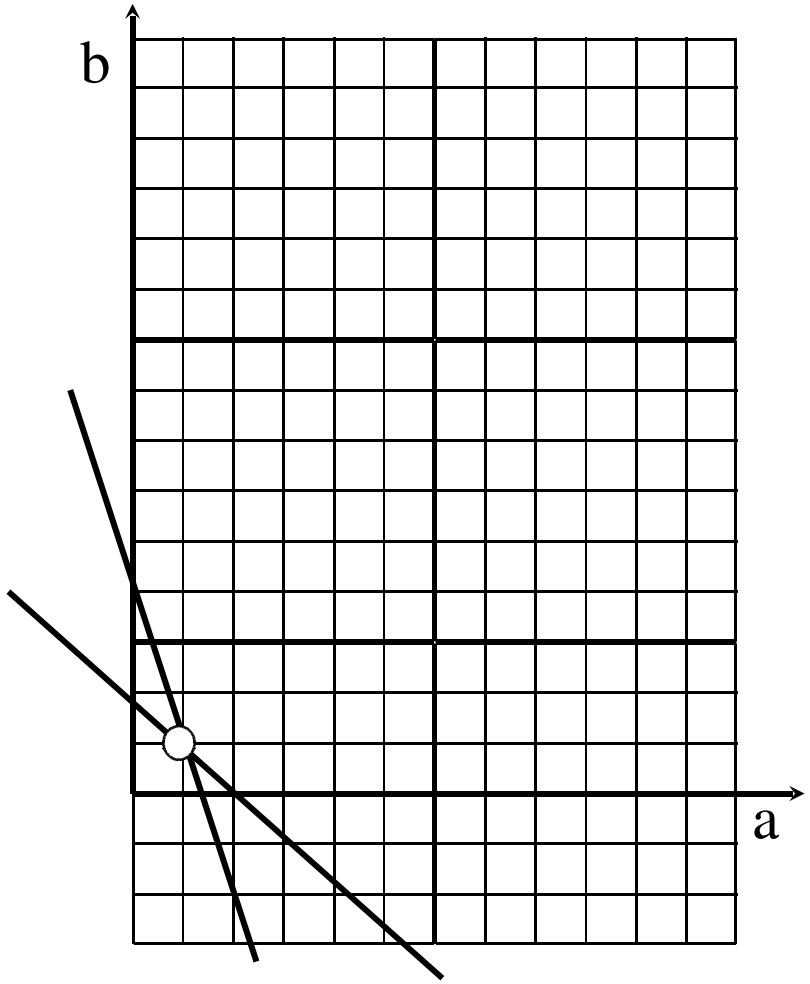


xy-space



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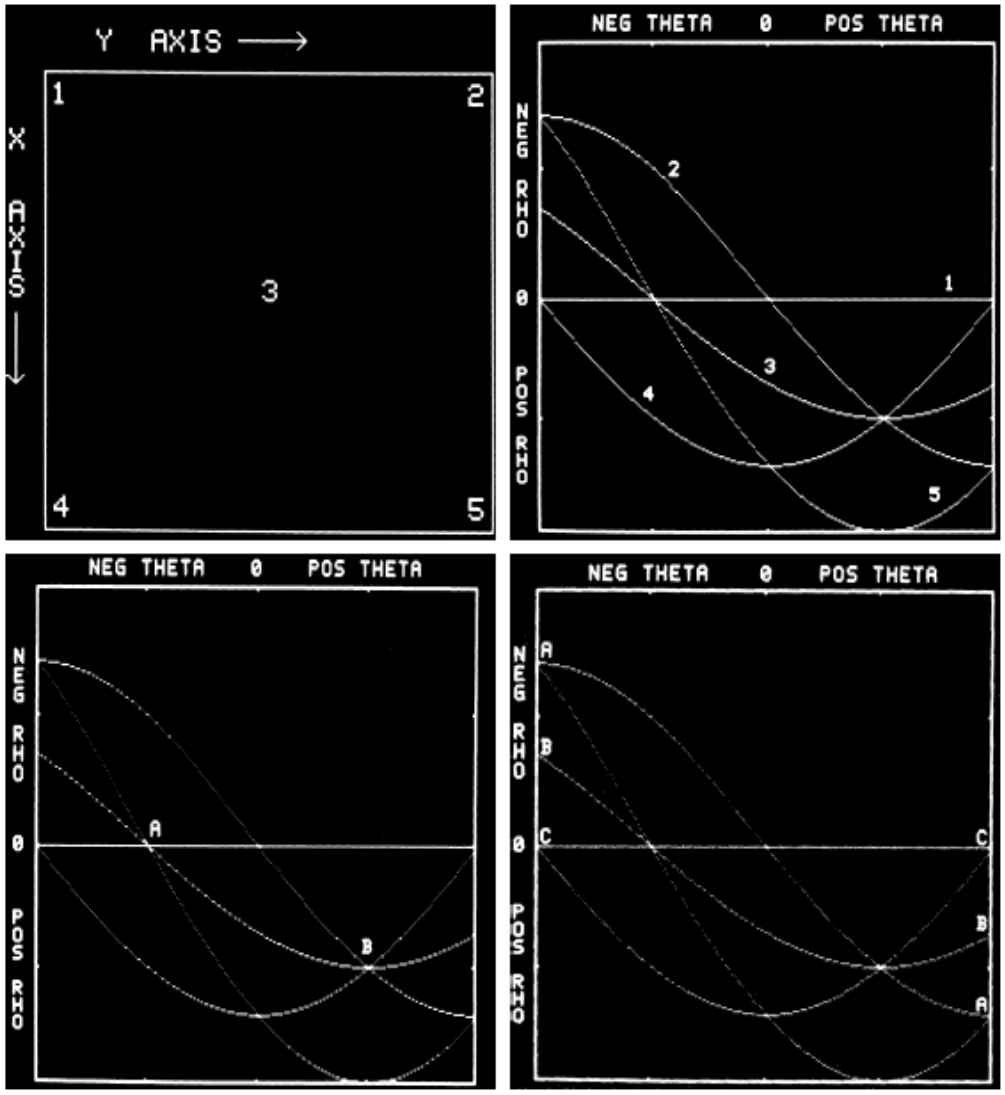
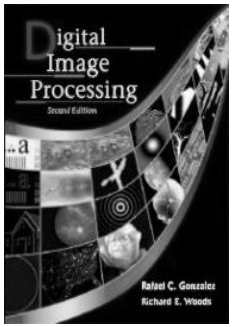
The Hough transform

a b
c d

FIGURE 10.20
Illustration of the Hough transform. (Courtesy of Mr. D. R. Cate, Texas Instruments, Inc.)





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