Segmentation

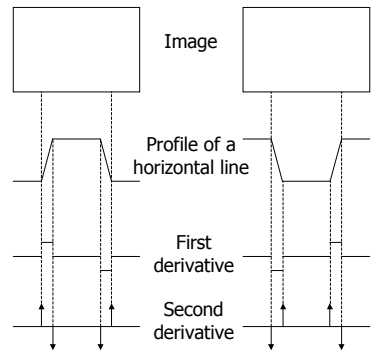
- To distinguish objects from background

Detection of discontinuities

- Initial preprocessing step for numerous object detection algorithms
- 1. Point Detection
- 2. Line Detection
- 3. Edge Detection

3. Edge Detection

- Most common approach for detecting discontinuities in gray level



Segmentation methods

- I. Edge Linking and Boundary Detection
- II. Thresholding
- III. Region Oriented Segmentation
- IV. Motion Based Segmentation

I. Edge Linking and Boundary Detection

- Edge Detection methods yield imperfect boundaries
  - noise, breaks due to nonuniform illumination, and other spurious discontinuities
- Hence follow by linking and other boundary detection procedures to assemble edge pixels into meaningful boundaries

Linking

- A point in the predefined neighbourhood of (x,y) is linked to the pixel at (x,y) if both the magnitude and direction criteria are satisfied

Edge Linking and Boundary Detection Methods

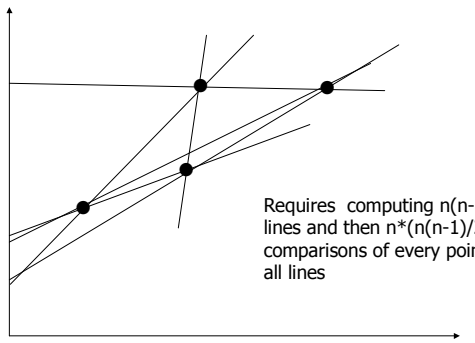
- I.a. Local Processing
- I.b. Global Processing
  - 1. Hough Transform
  - 2. Graph Theoretic Techniques

1.a. Local Processing

- Gonzalez Fig 10.16

I.b.1. Global Analysis via the Hough transform

- To determine whether pixels lie on a curve of specified shape
- Given n points from an image, find subsets of these points that lie on straight lines, say
- A crude approach: Find all lines determined by every pair of points and then find subsets of points that are close to particular lines



Requires computing n(n-1)/2 lines and then n*(n(n-1)/2) comparisons of every point to all lines

Hough Transform

- Suppose the line is yi = axi + b
  We need to find a and b
  Can be written as b = -xia + yi
  Divide the parameter space into accumulator cells with K increments
  The number of computations is reduced to nK
  Can detect disrupted or incomplete lines
  Gonzalez Fig 10.17 to 10.21

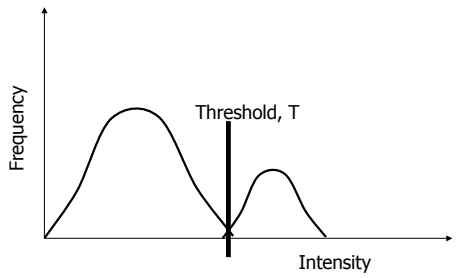
I.b.2. Global Analysis via Graph Theoretic Techniques

- Represents edge segments in the form of a graph and searches the path for low-cost paths that correspond to significant edges
- Performs well in the presence of noise
- More complicated and requires more processing
  Gonzalez Fig 10.25

II. Thresholding

- Main technique for object detection
- a point or level at which something begins or starts to take effect
- Consider a light object on a dark background
- Intensities can be grouped into two dominant modes

Histogram of such image



Thresholding function

- Select a threshold T which separates the intensity modes
- If f(x,y)>T; (x,y) is object
- Else, (x,y) is background
- T=T[x,y,p(x,y),f(x,y)]
  - where f(x,y) is the intensity of point (x,y) and p(x,y) denotes some local property measured in a neighborhood of this point.

Thresholded image

- Thresholded image is given by
- g(x,y)=1 if f(x,y)>T
- g(x,y)=0 if f(x,y)<=T

Types of thresholds

- II.a. Global Threshold
  - if T depends only on f(x,y)
  - Gonzalez Fig 10.28
- II.b. Local Threshold
  - if T also depends on p(x,y)
- II.c. Dynamic Threshold
  - if T also depends on spatial coordinates x and y

Optimum Threshold Selection

- Estimating a threshold that produces minimum average segmentation error
- If P_1 and P_2 are the probabilities of occurrence of the two classes of pixels, $p_1(z)$ and $p_2(z)$ are the probability density functions of the two peaks,
- $P_1p_1(T) = P_2p_2(T)$ should be solved to obtain the optimum threshold T
- One of the earliest examples Gonzalez Figure 10.33

III. Region Oriented Segmentation

- III.a. Region Growing
- III.b. Region Splitting and merging

III.a. Region Growing

- Start with a set of seed points
- Append to each seed neighbouring pixels that have properties similar to the sed, such as specific ranges of gray level or colour
- Gonzalez Fig 10.40

III.b. Region Splitting and Merging

- Subdivide an image initially intp a set of arbitrary, disjointed regions and then merge and/or split the regions
- Gonzalez Fig 10.43

IV. Motion Based Segmentation

- IV.a. Spatial Techniques
- IV.b. Frequency Domain Techniques

IV.a. Spatial Techniques

- To detect changes between two frames $f(x,y,t_i)$ and $f(x,y,t_j)$ taken at times t_i and t_j respectively
- Determine a difference image
- $d_{ij}(x,y) = 1$ if $|f(x,y,t_i) - f(x,y,t_j)| > T$
  $= 0$ otherwise
- where T is a specified threshold

Accumulative Difference Image

- Isolated entries resulting from noise is a serious problem
- One workaround is to consider changes at a pixel location over several frames
- An ADI is formed by comparing the reference image with every subsequent image in the sequence
- Gonzalez Fig 10.49, 10.50 (Slide 50)

IV.b. Frequency domain techniques

- Use a Fourier transform to determine motion
- Gonzalez Fig 10.51 to 10.54 Slides 52-55

Summary

- Image segmentation is an essential preliminary step in most automatic pictorial pattern recognition and scene analysis problems

Description