Image Segmentation

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Segmentation

- Segmentation:
  - Input: Image ,Output: Attribute
  - Subdivides an image into constituent regions or objects of interests.
- Segmentation is based on:
  - Discontinuity:
    - Edge/Abrupt changes in intensity
      → Edge detection+ edge connection (assemble edge segments into longer edge)
  - Similarity:
    - Thresholding → Fast Speed, popular
    - Region growing, splitting and merging → morphological/watershed seg
- Segmentation Accuracy:
  - When to stop: No past the level of detail required to identify those objects.
  - Good sensor: Diminishing the contribution of irrelevant image detail.

Detection of Discontinuities

Detection of Discontinuities

- Detect by masking (sum to 0) $R = \sum_{i=1}^{9} w_i z_i$
  - Point Detection
    - Isolated point: |R|≥T (T controls the degree)
  - Line Detection
    Case 1: Ex: $|R_1|>|R_j|$, j=2,3,4 → Point is most likely associated with horizontal line
    Case 2: we are interested in detect a line in a specified direction
  - Edge Detection
    - Gradient
    - Laplacian
      - Double Edge: undesired for segmentation
      - Unable to detect edge direction

Sobel is better than Prewitt:
Slightly superior in noise-suppression

Point Detection

T: set the interests, 90% of the highest absolute pixel value

−1	−1	−1
−1	8	−1
−1	−1	−1

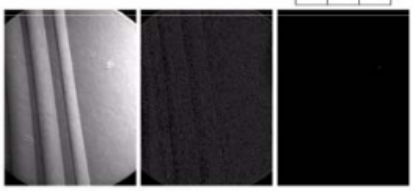
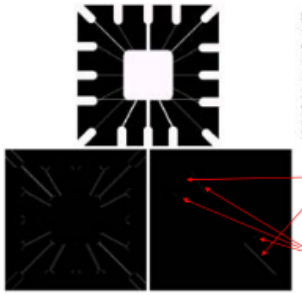


FIGURE 10.2 (a) Point detection mask. (b) X-ray image of a turbine blade with a porosity. (c) Result of point detection. (d) Result of using Eq. (10.1-2). (Original image courtesy of X-TEK Systems Ltd.)

Industry inspection: a porosity in turbine blade

Line Detection



Because TH=max value
Only detect one-pixel thick

Point detection can remove isolated points

Industry inspection: find -45º Line with one pixel thick

Edge Detection

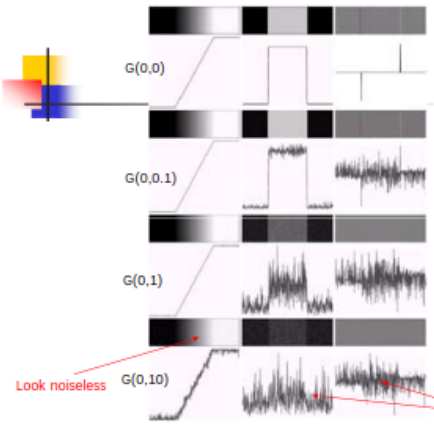
- Zero Crossing Property by 2nd derivative

Ideal edge (thin)

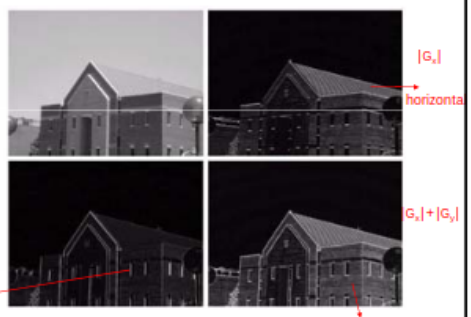
Ramp/Blurred Edge (thick)

Zero Crossing

(thin edge) by locating the centers of thick edge



Edge detection by Gradient



Smooth+Gradient

Diagonal edge detection

5x5 smooth+45° Prewitt

5x5 smooth+45° Sobel

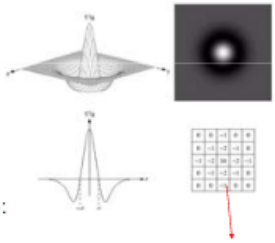
Gaussian LPF + Laplacian

- To reduce the double edge, and the effect of noise
- Gaussian LPF (σ controls the degree of blurring):

$$h(r) = -e^{-\frac{r^2}{2\sigma^2}} \quad , r^2 = x^2 + y^2$$

- Laplacian of Gaussian (LoG)(Mexican hat fun):

$$\nabla^2 h(r) = -\left[\frac{r^2 - \sigma^2}{\sigma^4}\right] e^{-\frac{r^2}{2\sigma^2}}$$



5x5 example: Must sum to 0