
Edge linking
Boundary detection

Edge linking algorithms

+Local Processing

+Regional Processing

+Global Processing

Local Processing

- Knowledge about edge points in a local region (e.g. 3*3 neighbourhood)

- Predefined criteria
  - Strength
  - Direction

Strength and Direction criteria

$|M(s,t) - M(x,y)| \leq E$ (positive threshold)

$|\alpha(s,t) - \alpha(x,y)| \leq A$ (positive angle threshold)

Pixel with coordinates (s,t) in S_{xy} is linked to pixel at (x,y) if both magnitude and direction criteria are satisfied.

Modified Local Processing algo

1. Compute M(x,y) and α(x,y) matrices of input image f(x,y).
2. Form binary image g as follows

$$g(x,y) = 1 \text{ if } M(x,y) > TM \text{ AND } \alpha(x,y) = A \pm TA$$

$$g(x,y) = 0 \text{ otherwise}$$

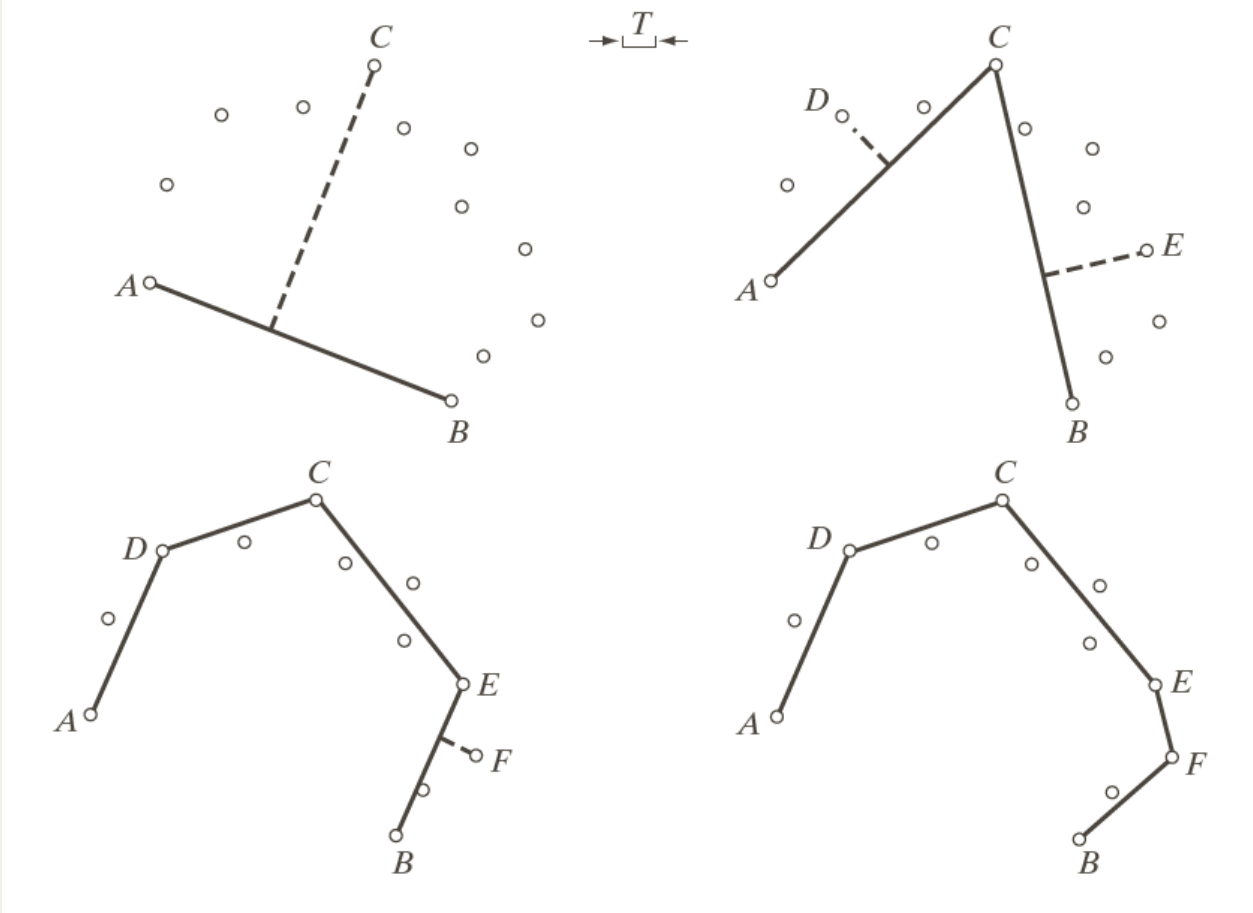
3. Scan the rows of g and fill (set to 1) all gaps (sets to 0s) in each row that do not exceed a specified length K.
4. To detect gaps in any other direction Ø, rotate g by this angle and apply horizontal scanning procedure in step 3. Rotate the result back by –Ø.

Results

Regional Processing

+ The location of regions of interest in an image are known or can be determined.
+ Fitting of 2D curve (POLYGON) to the known points.

Regional Processing



Regional Processing algo

1. Let P be a sequence of ordered, distinct, 1-valued points of a binary image. Specify two starting points, A and B. These are the two starting vertices of the polygon.
2. Specify a threshold, T, and two empty stacks, OPEN and CLOSED.
3. If the points in P correspond to a closed curve, put A into OPEN and B into OPEN and into Closed. If the points correspond to an open curve, put A into OPEN and B into CLOSED.

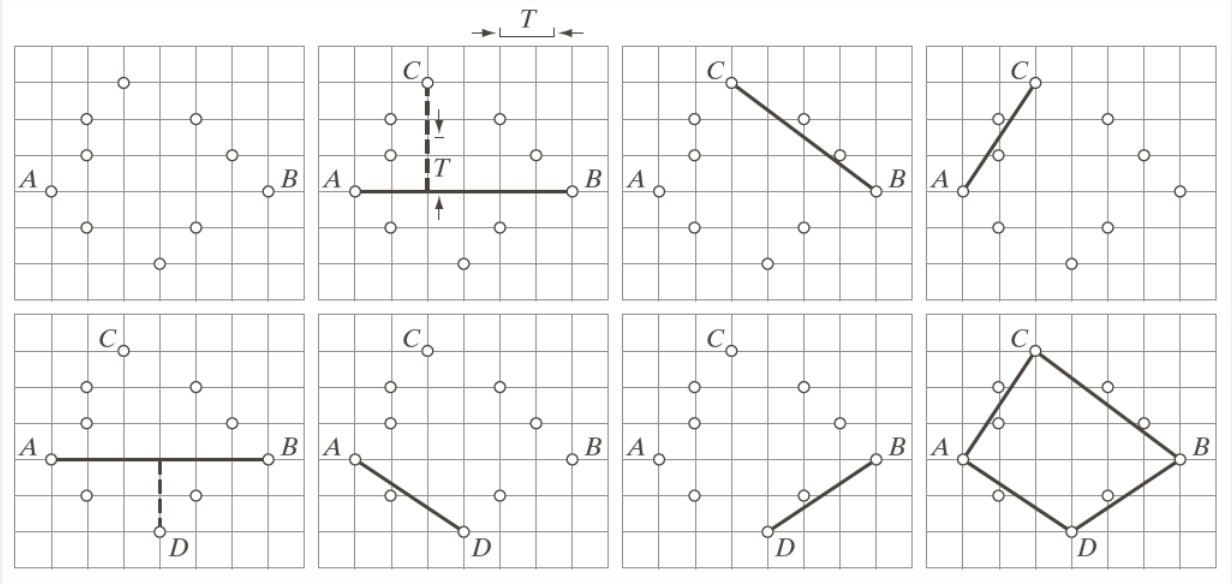
Regional Processing algo cntd...

4. Compute the parameters of the line passing from the last vertex in CLOSED to the last vertex in OPEN.
5. Compute the distance from the line in Step 4 to all the points in P whose sequence places them between the vertices from Step 4. Select the points V_{max}, with the maximum distance, D_{max} (ties are resolved arbitrarily).
6. If $D_{max} > T$, place V_{max} at the end of the OPEN stack as a new vertex. Go to step 4.

Regional Processing algo cntd...

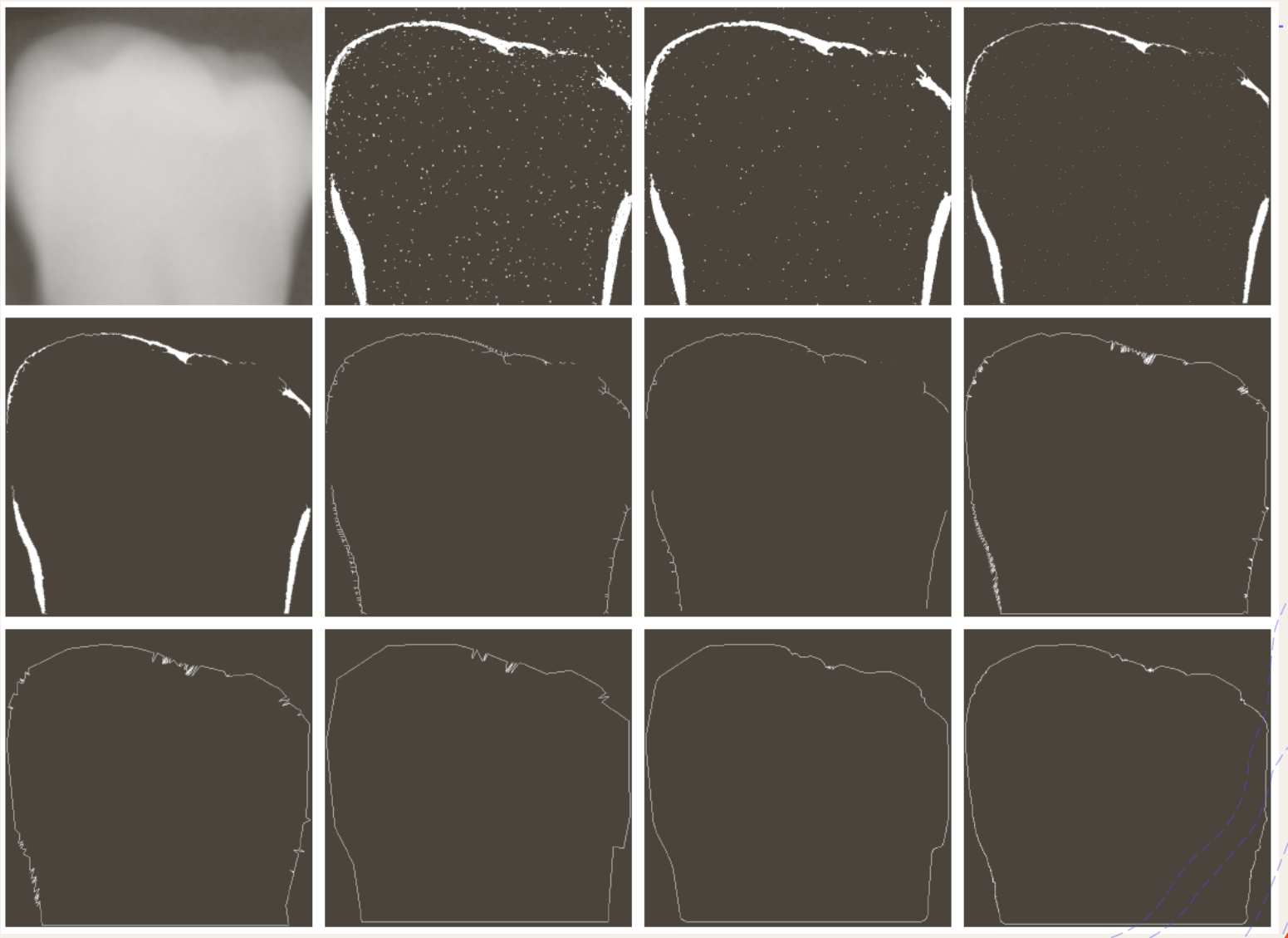
7. Else, remove the last vertex from OPEN and insert it as the last vertex of CLOSED.
8. If OPEN is not empty, go to Step 4.
9. Else, exit. The vertices in CLOSED are the vertices of the polygon fit to the points in P.

Regional Processing



CLOSED	OPEN	Curve segment processed	Vertex generated
B	B, A	—	A, B
B	B, A	(BA)	C
B	B, A, C	(BC)	—
B, C	B, A	(CA)	—
B, C, A	B	(AB)	D
B, C, A	B, D	(AD)	—
B, C, A, D	B	(DB)	—
B, C, A, D, B	Empty	—	—

Boundary detection of human tooth



a b c d
e f g h
i j k l

FIGURE 10.30 (a) A 550 × 566 X-ray image of a human tooth. (b) Gradient image. (c) Result of majority filtering. (d) Result of morphological shrinking. (e) Result of morphological cleaning. (f) Skeleton. (g) Spur reduction. (h)–(j) Polygonal fit using thresholds of approximately 0.5%, 1%, and 2% of image width (T = 3, 6, and 12). (k) Boundary in (j) smoothed with a 1-D averaging filter of size 1 × 31 (approximately 5% of image width). (l) Boundary in (h) smoothed with the same filter.

Lab exercise

+Write a program for edge linking and boundary detection using the three techniques discussed in this lecture.