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DIP Lecture 12

Morphological Operations

→ Set of non-linear operations related to shape of object

Morphology ⇒ Shape

→ Object/Region = Set of pixels where 0 = bg
1 = fg

Morphological processing

Set of theoretical operations like planet phenotyping

Operations: $A \cup B, A \cap B, A \vee B, A^c, A - B$

Structuring element/kernel:

Matrix of pixels for a binary image

Parameters of structuring element:

→ Size of structuring element i.e. dimensions

→ Shape of structuring element [sets of 0's & 1's

example: $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ cross

→ origin of structuring element, one of its pixels doesn't need to be at center or can be outside based on operation

Erosion:

→ Makes objects look thinner

→ Morphological operation

→ Take 3×3 struct element with origin at center

→ When SE lies within region of 1's, we retain 1 at origin, even if SE doesn't fully fit then don't retain, set it to 0

i.e. pixels eroded away.

→ SE operates w.r.t origin [decide on your own]

→ Diff shapes of SE ⇒ diff outputs

→ 

Holes becomes larger
Image gets darker

Used in counting coins, binarising images.

⇒ In ⊖E, if disk has radius r, as radius increases ⇒ Erosion is more

Can be taken as min filter

→ Representation: $f \ominus S \rightarrow S.E$ ↓ Bin. Img

it removes small objects

Dilation:

SE origin overlaps with 1, put 1's over all positions SE occupies

→ 

Lighter image
Smaller hole

MAX FILTER TYPE

Representation: $f \oplus S$

Boundary Detection:

① Dilation:
- → Dilate inp. img
- → Sub. I/P from dilated img
- → Boundaries are left

② Erosion:
- → Erosion I/P img
- → Subs. eroded img from i/p
- → Boundaries are left

① $(A \oplus B) - A$ ↓ ext. boundary

② $A - A \ominus B$ ↓ int. boundary

③ $A \oplus B - (A \ominus B)$ ↓ Thicker boundaries

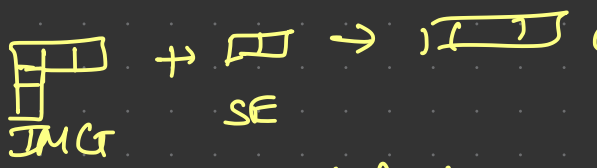
→ 8 connectivity due to 8 neigh. pixels connected

→ 4 connectivity cuz 4 neigh. pixels connected

Compound operations:

① Opening: [Affects fg]

→ Erosion than dilation
→ Take SE & slide it inside each foreground region
→ FG pixels covered by SE with SE being entirely within fg region will be preserved
→ All FG pix. that aint reached by SE without lapping over edge of fg will be eroded.



→ Use 3×4 se to retain vertical bars
→ Use large SE that can fit inside big blobs but not small blobs to remove small blobs
→ Removes salt noise [small blobs from fg]
→ Same SE for erosion & dilation
→ Idempotent: No further effect after repeated application
→ Representation: $f \circ s = (f \ominus s) \oplus s$

② Closing: [Affects bg]

→ Dilate than erode
→ Take SE & slide it outside fg region
→ For big pixels that can't be touched by SE without coming inside fg change to fg
→ Closes small holes in fg while keeping initial region sizes

→ INDEMPODENT: No effect on repeated application

→ REPRESENTATION: $f \cdot s = (f \oplus s) \ominus s$

→ Removes pepper noise

Example:
- → Threshold to get fg/bg
- → Close with disc of size 20

Thin narrow gaps in fg is filled so that it can be considered as single object

→ Closing is ideal for skeletonization operations etc for further processing and selection

→ Opening & closing are complementary [duality]

→ REPRESENTATION:

$(f \cdot s)^c = f^c \circ \hat{s}$

$(f \circ s)^c = f^c \cdot \hat{s}$

→ Apply closing with $\hat{s}$ on f^c is same as opening with s on f complemented.

→ Used to remove salt noise with opening & fixing narrow breaks with opening, closing respectively to noisy fingerprint

Dilation & closing → Extending operations [↑ fg]

Erosion & opening → Narrowing operations [↓ fg]

$(f \ominus s)(x) \leq (f \circ s)(x) \leq f(x) \leq (f \cdot s)(x) \leq (f \oplus s)(x)$

→ for fg pixels

$F(f \ominus s) \leq F(f \circ s)(x) \leq f(x) \leq F(f \cdot s) \leq F(f \oplus s)$

Erosion → Min filter → Darker
Dilation → Max filter → Lighter
} Not exactly but analogous as it depends on shape, origin etc.