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FACULTY OF EGINEERING

Digital Image Processing
LECTURE-19

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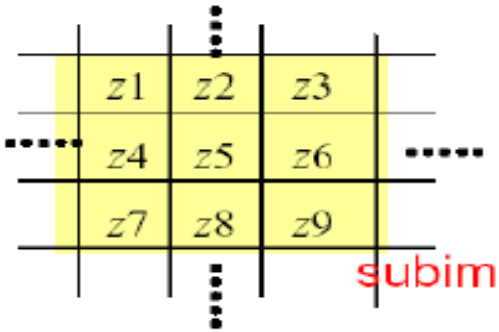
OUTLINE

- Logic Operations
- Basics of Spatial Filtering
- Spatial Filtering for Smoothing
- Smoothing Filters
- Smoothing Spatial Filters
- Spatial Filtering for Smoothing (Example)
- MCQ
- References

Logic Operations

- Given the 3×3 mask with coefficients: w_1, w_2,…, w_9
- The mask covers the pixels with gray levels: z_1, z_2,…, z_9



subimage

w1	w2	w3
w4	w5	w6
w7	w8	w9

Mask coefficients

$$z_5 \leftarrow z = w_1 z_1 + w_2 z_2 + \cdots + w_9 z_9 = \sum_{i=1}^{9} w_i z_i$$

- z gives the output intensity value for the processed image (to be stored in a new array) at the location of z5 in the input image

Basics of Spatial Filtering

Mask operation near the image border

Problem arises when part of the mask is located outside the

image plane; to handle the problem:

1. Discard the problem pixels (e.g. 512x512input 510x510output, if mask size is 3x3)

2. Zero padding: expand the input image by padding zeros

(512x512input 514x514output)

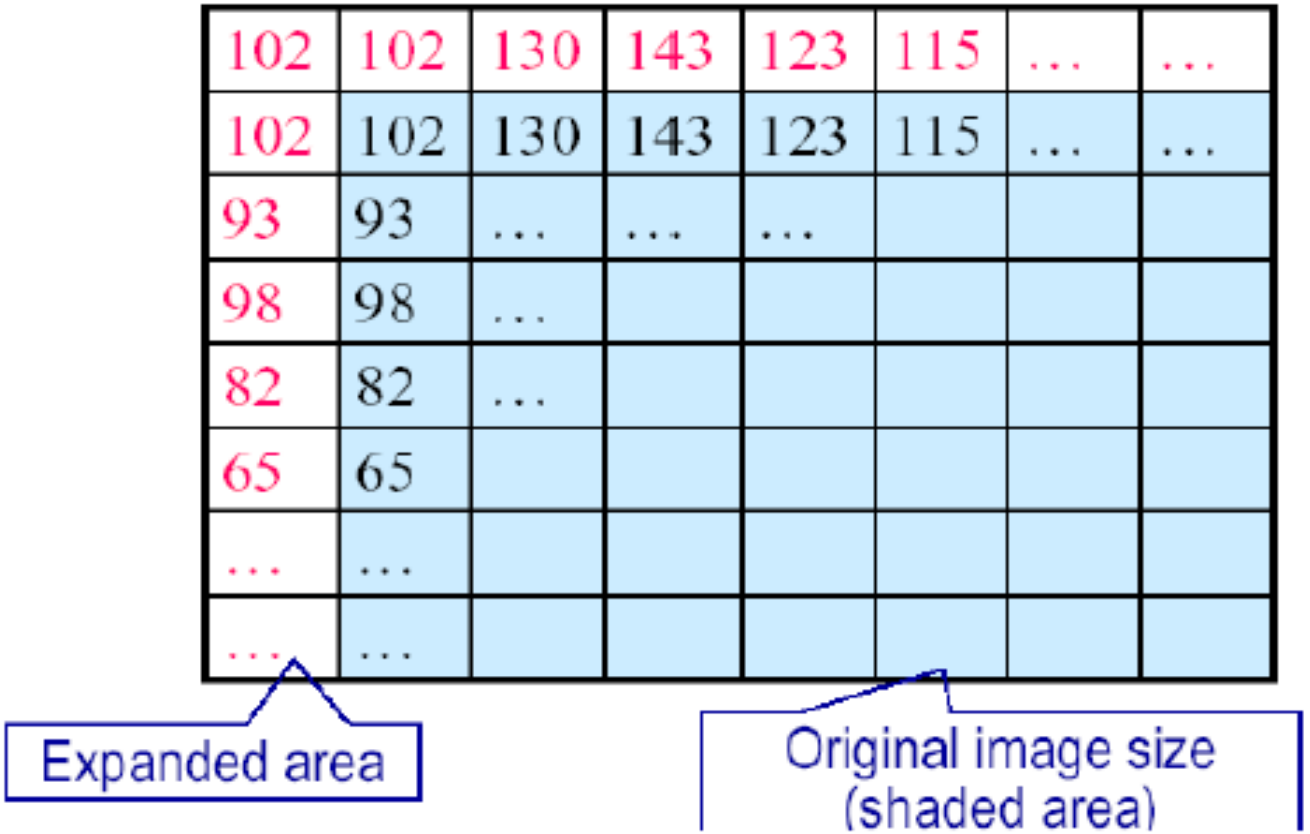
– Zero padding is not good; creates artificial lines or edges on the

border

3. We normally use the gray levels of border pixels to fill up the expanded region (for 3x3 mask). For larger

masks a border region equal to half of the mask size is mirrored on the expanded region.

Mask Operation Near the Image Border

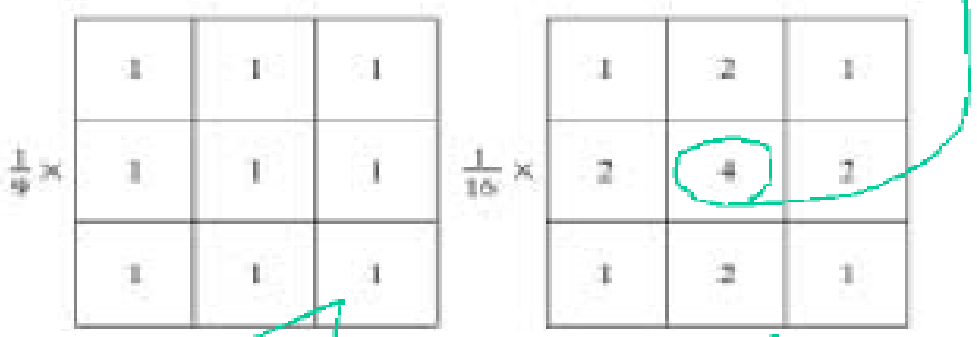


Spatial Filtering for Smoothing

- For blurring/noise reduction;
  - Blurring is usually used in preprocessing steps,
  - e.g., to remove small details from an image prior to object extraction, or to bridge small gaps in lines or curves
- Equivalent to Low-pass spatial filtering in frequency domain because smaller (high frequency) details are removed based on
  - neighborhood averaging (averaging filters)
- Implementation: The simplest form of the spatial filter for averaging is a square mask (assume m×m mask) with the same coefficients 1/m2 to preserve the gray levels (averaging).
- Applications: Reduce noise; smooth false contours
- Side effect: Edge blurring

Smoothing Filters

Consider the output pixel is positioned at the center



Box filter all coefficients are equal

Weighted average give more (less) weight to pixels near (away from) the output location

Consider mask size: $m \times n$

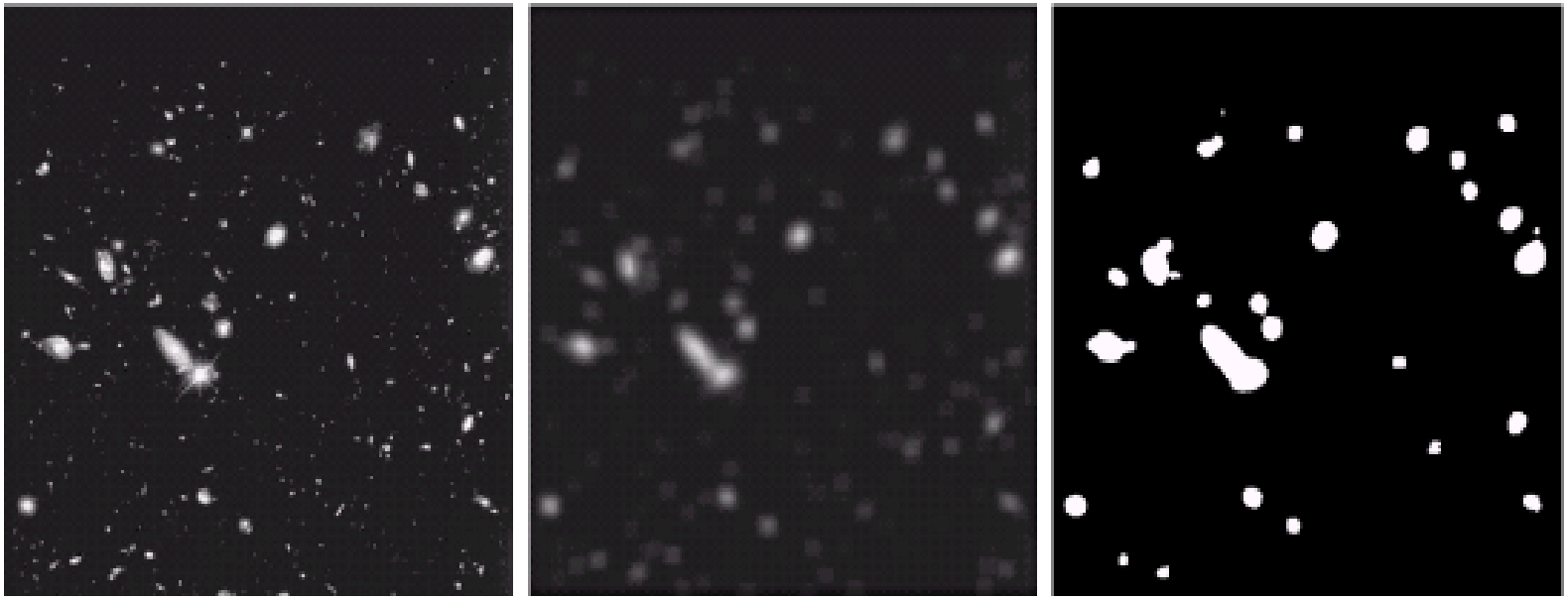
$$w_i = \frac{1}{mn}, i = 1, \ldots, mn$$

Smoothing Spatial Filters

- One of the simplest spatial filtering operations we can perform is a smoothing operation
  - Simply average all of the pixels in a neighbourhood around a central value
  - Especially useful in removing noise from images
  - Also useful for highlighting gross detail

$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$
$1/9$	$1/9$	$1/9$

Spatial Filtering for Smoothing (Example)



a b c

FIGURE 3.36 (a) Image from the Hubble Space Telescope. (b) Image processed by a 15 × 15 averaging mask. (c) Result of thresholding (b). (Original image courtesy of NASA.)

MCQ

1. Which of the following is the primary objective of sharpening of an image?
   a) Blurring the image
   b) Highlight fine details in the image
   c) Increase the brightness of the image
   d) Decrease the brightness of the image

2. Image sharpening process is used in electronic printing.
   a) True
   b) False

3. In spatial domain, which of the following operation is done on the pixels in sharpening the image?
   a) Integration
   b) Average
   c) Median
   d) Differentiation

MCQ

4. Image differentiation enhances the edges, discontinuities and deemphasizes the pixels with slow varying gray levels.

   a) True

   b) False

5. In which of the following cases, we wouldn't worry about the behaviour of sharpening filter?

   a) Flat segments

   b) Step discontinuities

   c) Ramp discontinuities

   d) Slow varying gray values

References

- https://www.javatpoint.com/digital-image-processing-tutorial
- https://www.geeksforgeeks.org/
- Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education.
- Digital Image Processing and Computer Vision, R.J. Schalkoff. Published by: JohnWiley and Sons, NY.
- Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall,Upper Saddle River, NJ.