Digital Image Processing, 2017

Exercise 2

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Problem 4: Smoothing and Histogram

Consider the contrast-stretched image from Problem 2 (last week): Suppose you apply a 3×3 moving average to the image. How does the histogram of the resulting image look? Is it different from the histogram of the image before applying the moving average? In which way is it different?

Problem 5: Median Filter

a) Try out explicitly what a 3 by 3 median filter does to a smooth image with an outlier (single pixel with a very large or very small value): Pixel value is 50 everywhere except for one pixel where it is 200. Then try what a 3 by 3 average does.

b) What happens if you have a block (say, 2×2, or 3×3) of such outliers? How can you filter out such blocks?

c) How does a median filter change
– edges
– corners
– lines
} in images[1]?

What would an average filter do to edges and corners?

d) What is the effect of modified mask/window forms (cross, . . .)

[1] By "edge" we mean the boundary between a bright and a dark area. Take, for example, a white square of, say, 10×10 pixels (pixel value 255) on black background (pixel value 0).

Problem 6: Applying convolution filters to an image

Take a grayscale digital image (e.g. the Bremen Marketplace image on the course web site) and use some standard image program (e.g. Gimp) to apply some convolution filters. In Gimp, you find it under the menu item *Filter* $\rightarrow$ *Generic* $\rightarrow$ *Convolution Matrix*, then you can design your own convolution mask. Use at least one filter with non-negative values, and one with positive and negative values. Comment on the result.

Problem 7: Gradient Operator in 1 Dimension

Apply the gradient operator in 1 dimension, $h = (-1, 1)$ to the following one-dimensional "images":

- $0, 0, 0, 0, 0, 0, 10, 10, 10, 10, 10, 10$
- $0, 0, 1, 3, 5, 6, 7, 9, 10, 10, 10, 10$
- $10, 10, 10, 10, 10, 10, 0, 0, 0, 0, 0, 0$

Discuss the result. What is different if you use , $h = (1, -1)$ instead?

Problem 8: Gradient Operator

For a 2-dimensional image, a horizontal gradient operator can be defined as:

$$h = \begin{bmatrix} -1 & 0 & 1 \end{bmatrix}$$

a vertical gradient operator:

$$h = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$$

and the Laplace operator (with inverted sign)

$$h = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

What is the effect of these filters on

- an image showing a bright square on dark background?
- vertical edges?

- horizontal edges?
- diagonal edges?
- lines?