Some of the theoretical contents are taken from the instructor manual of the book „Digital Image Processing (4th Edition)“ by Rafael C. Gonzalez and Richard E. Woods. Therefore, the confidentiality class of this document is „internally extended“. The data can be used by OST members as of September 1, 2020, but must not be passed on to third parties.

Image Processing and Computer Vision 1

Chapter 5 – Non-linear filters for noise reduction – week 11

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1 Book

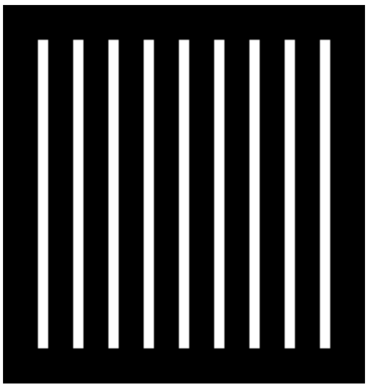
1.1 Book by Gonzalez and Woods, 5.1

The white bars in the test pattern shown are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of

(a) a 3×3 arithmetic mean filter?

(b) a 7×7 arithmetic mean filter?

(c) a 9×9 arithmetic mean filter?



Note: This problem and the ones that follow it, related to filtering this image, may seem a bit tedious. However, they are worth the effort, as they help develop a real understanding of how these filters work. After you understand how a particular filter affects the image, your answer can be a brief verbal description of the result. For example, “the resulting image will consist of vertical bars 3 pixels wide and 206 pixels high.” Be sure to describe any deformation of the bars, such as rounded corners. You may ignore image border effects, in which the masks only partially contain image pixels.

See script Labs/week11/Python/a5.1-5.9.py

1.2 Book by Gonzalez and Woods, 5.3

Repeat Problem 5.1 using a harmonic mean filter.

See script Labs/week11/Python/a5.1-5.9.py

1.3 Book by Gonzalez and Woods, 5.5

Repeat Problem 5.1 using a contraharmonic mean filter with $Q = -1$.

See script Labs/week11/Python/a5.1-5.9.py

1.4 Book by Gonzalez and Woods, 5.7

Repeat Problem 5.1 using a max filter.

See script Labs/week11/Python/a5.1-5.9.py

1.5 Book by Gonzalez and Woods, 5.9

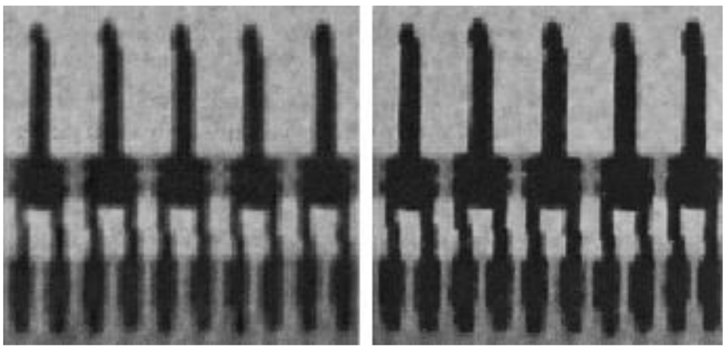
Repeat Problem 5.1 using a midpoint filter.

See script Labs/week11/Python/a5.1-5.9.py

1.6 Book by Gonzalez and Woods, 5.10

The two subimages shown were extracted from the top right corners of Figs. 5.7(c) and (d), respectively. Thus, the subimage on the left is the result of using an arithmetic mean filter of size 3×3, and the other subimage is the result of using a geometric mean filter of the same size.

(a) Explain why the subimage obtained with geometric mean filtering is less blurred. (*Hint*: Start your analysis by examining a 1-D step transition in intensity.)



Book Fig. 5.7

The key to this problem is that the geometric mean is zero whenever any pixel is zero. Draw a profile of an ideal edge with a few points valued 0 *and a few points valued* 1*. The geometric mean will give only values of* 0 *and* 1*, whereas the arithmetic mean will give intermediate values (blur).*

Note by the lecturer: consider the variables a *and* $a + x$*, with* $x,\ a \in \mathbb{R}_+$*. The geometric mean of* a *and the somewhat larger value* $a + x$ *is*

$$\sqrt{a \cdot (a + x)} = \sqrt{a^2 + ax} < \sqrt{a^2 + ax + \frac{x^2}{4}} = a + \frac{x}{2} = \frac{a + (a + x)}{2}$$

On the left side of this inequality is the geometric mean, on the right side the arithmetic mean. From the inequality one can conclude that the geometric mean tends towards values that are smaller than the arithmetic mean, i.e. high value regions do fade out more into low value reagions than it is the case for the arithmetic mean. This result can be generalized to an arbitrary number of variables.