EQ2330 – Image and Video Processing

Exercise #2: Linear Processing

The problems are taken from R. C. Gonzales and R.E. Woods. *Digital Image Processing*, (second ed.), Prentice Hall, Upper Saddle River, New Jersey, 2002.

Problems to be solved in the classroom

1. **Problem 3.22** The three images shown (Fig. 1) were blurred using square averaging masks of sizes $n = 23, 25$, and 45 respectively. The vertical bars on the left lower part of (a) and (c) are blurred, but a clear separation exists between them. However, the bars have merged in image (b), in spite of the fact that the mask that produced this image is significantly smaller than the mask that produced image (c). Explain this.

(a) (b) (c)

Figure 1: Three images from Problem 3.22. The vertical bars are 5 pixels wide and 100 pixels high, and their separation is 20 pixels before blurring.

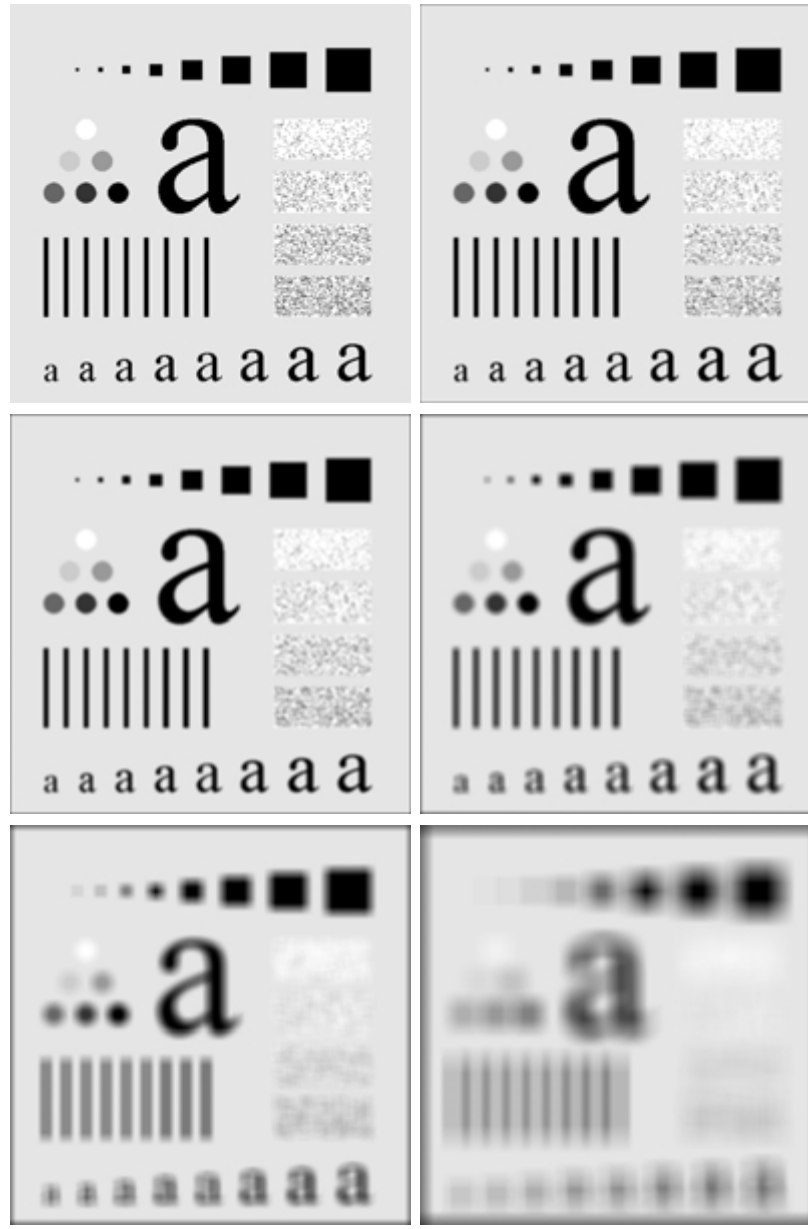
2. **Problem 3.24** In a given application an averaging mask is applied to input images to reduce the noise, and then a Laplacian mask is applied to enhance small details. Would the result be the same if the order of these operations were reversed?

3. **Problem 3.26** Give a 3×3 mask for performing unsharp masking in a single pass through an image.

4. **Problem 3.27** Show that subtracting the Laplacian from an image is proportional to unsharp masking. Use the following definition for the Laplacian:

$$\nabla^2 f = [f(x+1, y) + f(x-1, y) + f(x, y+1) + f(x, y-1)] - 4f(x, y)$$

5. **Problem 3.16** In an industrial application, X-ray imaging is to be used to inspect the inside of certain composite castings. The objective is to look for void in the casting, which typically appear as small blobs in the image. However, due to properties of the casting material and X-ray energy used, high noise content often makes inspection difficult, so the decision is made to use image averaging to reduce the noise and thus improve visible contrast. In computing the average, it is important to keep the number of images as small as possible to reduce the time that parts have to remain stationary during imaging. After numerous experiments, it is concluded that decreasing the noise variance by a factor of 10 is sufficient. If the imaging device can produce 30 frames/s, how long would the castings have to remain stationary during imaging to achieve the desired decrease in variance. Assume that the noise is uncorrelated an has zero mean.



a b
c d
e f

FIGURE 3.35 (a) Original image, of size 500 × 500 pixels. (b)–(f) Results of smoothing with square averaging filter masks of sizes $n = 3, 5, 9, 15$, and 35, respectively. The black squares at the top are of sizes 3, 5, 9, 15, 25, 35, 45, and 55 pixels, respectively; their borders are 25 pixels apart. The letters at the bottom range in size from 10 to 24 points, in increments of 2 points; the large letter at the top is 60 points. The vertical bars are 5 pixels wide and 100 pixels high; their separation is 20 pixels. The diameter of the circles is 25 pixels, and their borders are 15 pixels apart; their gray levels range from 0% to 100% black in increments of 20%. The background of the image is 10% black. The noisy rectangles are of size 50 × 120 pixels.