Exercise 5.1

– Show that the following filter performs smoothing followed by differentiation.

1	0	-1
2	0	-2
1	0	-1

– Provide a complete process using this filter to produce a binary image of the edge points of the initial image (suggest a method that generates contours with a thickness of 1).

Exercise 5.2

Let us consider a 7×7 image:

3	3	1	3	3	3	4
0	3	3	3	3	3	3
3	3	3	2	3	3	12
12	3	3	3	3	12	12
10	12	2	3	3	12	12
12	14	12	12	12	12	11
11	12	12	12	10	12	12

(i) Detect the edges of this image using the Sobel filter (normalized), and apply a threshold of 3.5 on the gradient norm.

(ii) Segment this image into two regions using global thresholding.

(iii) Apply the averaging method with an initial threshold of 5.

(iv) Using 8-connectivity with the split-and-merge algorithm, segment the image I such that the variance within each region is less than 2.

(v) What is the difference between image segmentation and edge detection?

Exercise 5.3

Apply Otsu's method to the following image:

2	7	6	6
5	6	5	5
6	5	5	6
7	6	4	5

Exercise 5.4

Determine the filtered image and the edges obtained by applying a LoG (Laplacian of Gaussian) filter of size 5×5 with $\sigma = 1$. The threshold is 0.75 times the mean of the filtered

image. The borders are duplicated. The input image is as follows:

$$I = \begin{array}{|c|c|c|c|c|c|c|c|}\hline 147 & 163 & 179 & 186 & 191 & 194 & 197 & 157 \\ \hline 160 & 175 & 182 & 184 & 184 & 186 & 162 & 50 \\ \hline 141 & 163 & 170 & 175 & 174 & 133 & 38 & 3 \\ \hline 91 & 127 & 135 & 124 & 85 & 16 & 0 & 7 \\ \hline 113 & 126 & 121 & 117 & 18 & 0 & 1 & 10 \\ \hline 136 & 135 & 125 & 151 & 99 & 54 & 8 & 9 \\ \hline 148 & 150 & 159 & 161 & 149 & 106 & 89 & 20 \\ \hline 142 & 164 & 178 & 181 & 168 & 113 & 120 & 91 \\ \hline \end{array}$$

Answer the same questions for a Sobel filter of size 3×3 with a threshold of 1.2.

Exercise 5.5

Using the averaging method, determine the threshold for the 8-bit image I. The initial value is the mean of I. The process stops when the difference between two successive thresholds is less than 0.5. The image I is as follows:

$$I = \begin{array}{|c|c|c|c|}\hline 184 & 188 & 72 & 2 \\ \hline 188 & 163 & 22 & 5 \\ \hline 191 & 102 & 1 & 7 \\ \hline 182 & 45 & 2 & 6 \\ \hline \end{array}$$