KAIST
EE535 Digital Image Processing
Assignment 4

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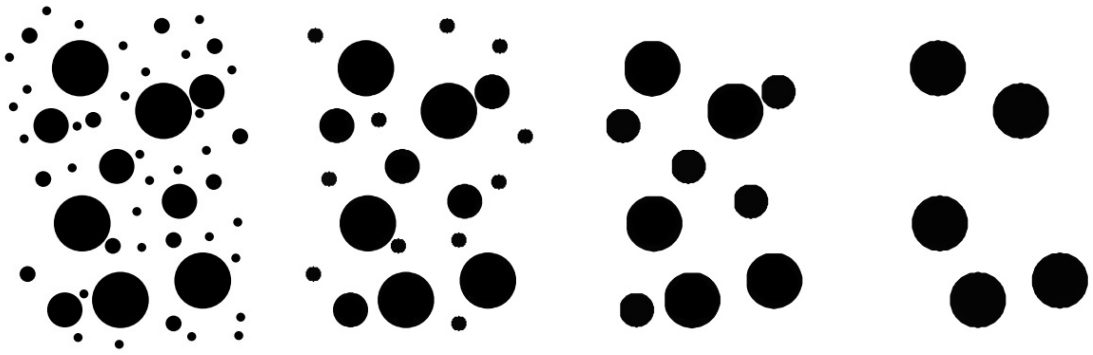
Morphological Operations

In this task, we aim to extract the largest five circles in the image given in Figure 1 (a) by using morphological operations. What we simply do is, first, generating a structure element that smaller than the largest five circles but can cover the others; then, by using this structure closing operation is applied. If dilation is followed by erosion this operation is called closing morphology where dilation fills intensity values in a neighborhood with the maximum one, erosion fills with the minimum. Maximum and minimum intensities in this binary image example are pure white and black. After dilation is applied, the area of the circles are reduced, erosion enlarges these regions back to their original sizes. In my implementation, I used circle [1] structures to remove black circles by increasing the radius from 15 to 45. Picking the structure with radius 45 resulted in only 5 largest circles in the image as shown in 1 (d).



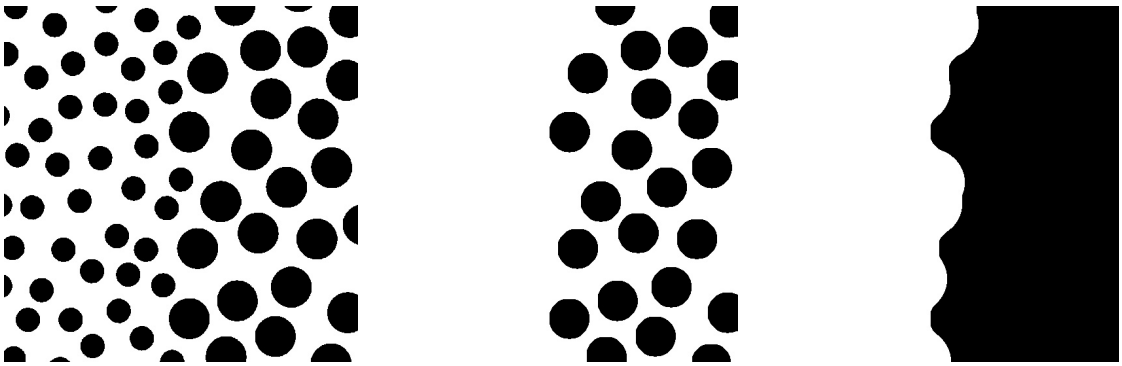
(a) Original (b) Closing by radius 15 (c) Closing by radius 30 (d) Closing by radius 45

Figure 1: Closing operation is applied onto original image by circle structures. From (b) to (d) structure sizes are increased.

[1] Formally, OpenCV's ELLIPSE structure is used.

Morphological Textural Segmentation

Closing and opening operations can be used for segmentation purpose. It is explained in above section that closing can remove objects in an image. If proper structure is chosen we can eliminate one texture while preserving the other. Based on this approach, if opening follows closing operation such that structuring element is slightly large enough to cover the white space between the blobs of remaining texture, output image will be segmented via bright and dark areas.

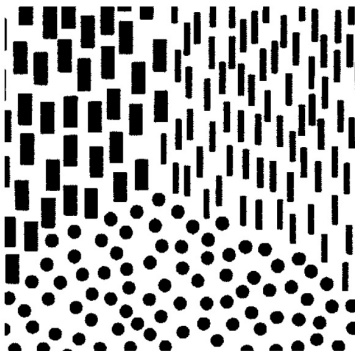


(a) Original image (b) Closing (c) Opening

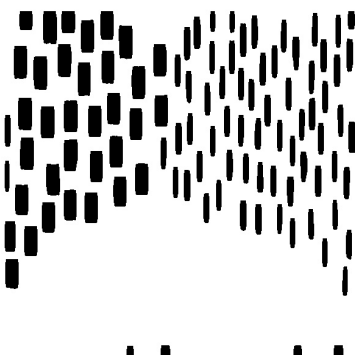
Figure 2: Additional toy example.

I started with an example from textbook to have better understanding. In Figure 2. Again, I used circle structures in this segmentation problem. Image is closed by radius 50 and opened by radius 100 circles. (c) shows the segmentation result.

Problem 2 In this task, we have multiple textures instead of two. Thus, I tried to segment each texture separately. Visually explaining, in Figure 3, original image (a) is closed by horizontal ellipse to only remove circles, see (b). Then, it is opened to darken rectangular regions in (c). By this morphology, a segmentation mask for circular region is obtained. In (d), closing operation is applied onto original image (a) to remove thin rectangles. Similarly, opening is followed for (d) to darken rectangle areas bu this time only bold ones, see (e). This result is a mask for summation of circular and thin rectangle areas. Difference between (c) and (e) gives separated mask for thin rectangle. Finally, we have 2 segmentation masks. A full dark image with the same shape of original image is initialized and obtained masks are located in this new segmentation output in (f).

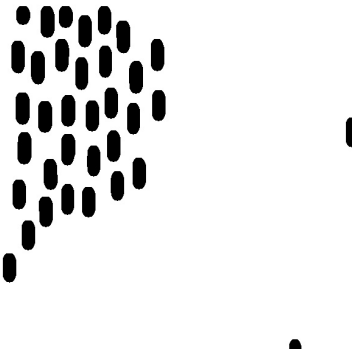


(a) Original image



(b) Closing for removing circles

(c) Opening for darkening both rectangular textures



(d) Closing for removing thin rectangles

(e) Opening for darkening bold rectangles

(f) Segmentation output

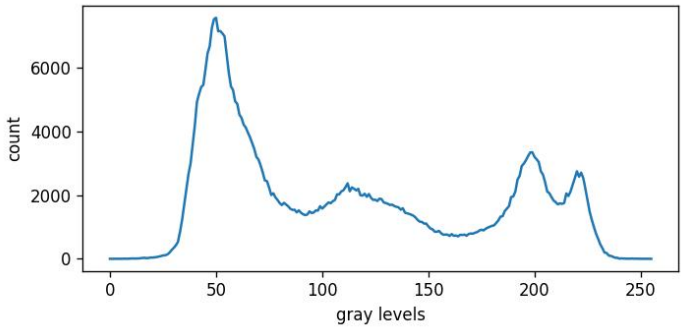
Figure 3: Multiple texture segmentation.

Problem 3 In this task, we are performing morphological operations on a colored image. Main goal is to enlarge the space between each coin.

First, we converted image into gray-scaled and plot histogram to specify the threshold intensity for further binary-conversion, see Figure 4.

(a) Original image

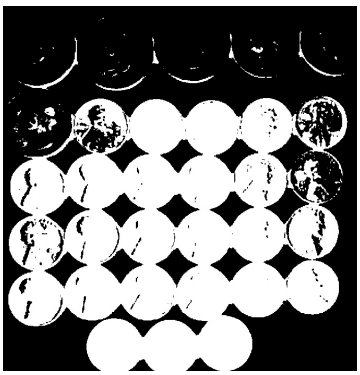
(b) Gray-scaled image



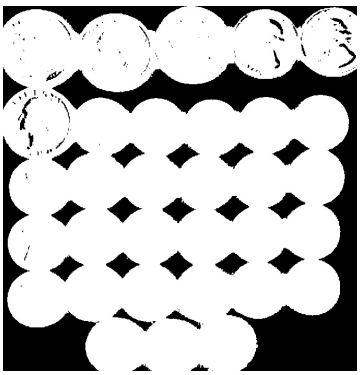
(c) Histogram of gray-scaled image

Figure 4: Input image and its gray-scaled histogram.

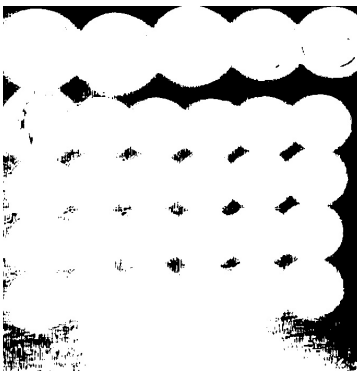
Figure 5 shows each binary output image when 80, 160 and 200 thresholds are applied. (b) seem to be the optimal result. (Possible values are picked by inspecting the histogram.)



(a) Threshold 80

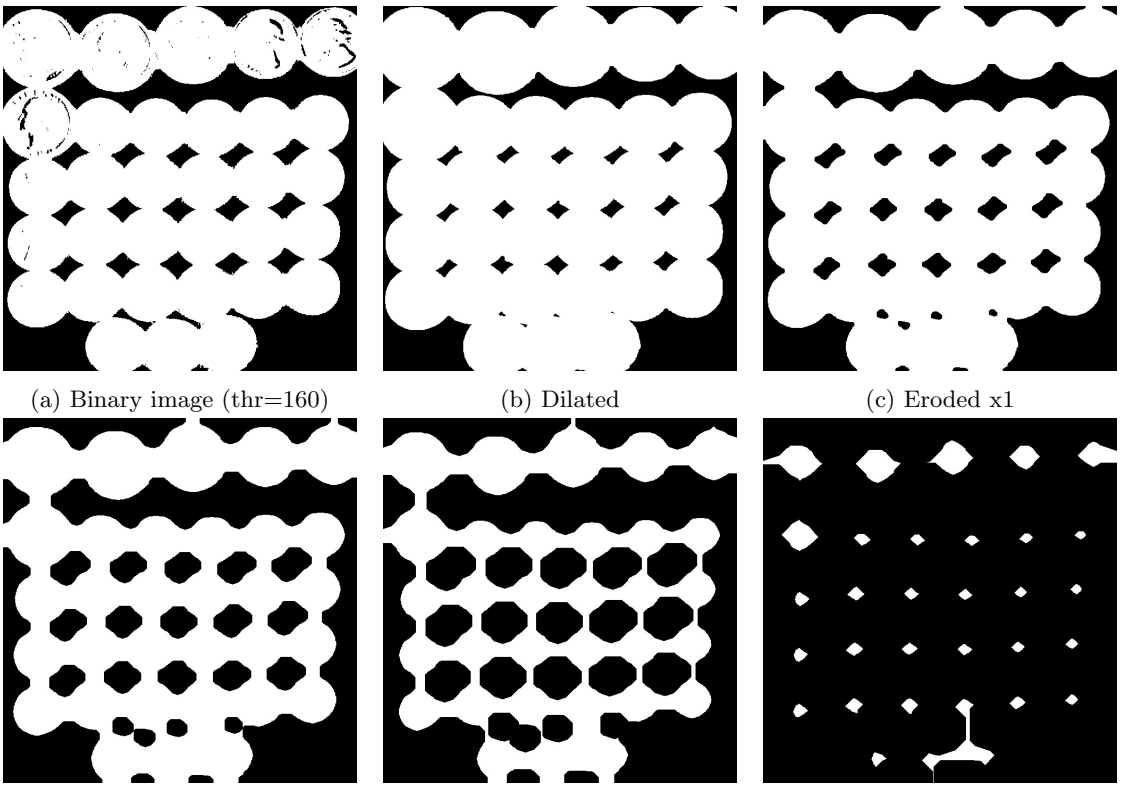


(b) Threshold 160



(c) Threshold 200

Figure 5: Binary (inverse) thresholding for 80, 160 and 200 thresholds.



(a) Binary image (thr=160) (b) Dilated (c) Eroded x1

(d) Eroded x3 (e) Eroded x5 (f) Eroded x10

Figure 6: Morphological operations in a sequential order to enlarge the space between coins.

Figure 6 shows the output of each morphological operation applied in a sequential order. An elliptic structuring element with radius 10 is picked, again. Input image (a) is dilated to fill the gaps on coin surfaces for preventing unwanted erosions in further operations, see (b). Then, dilated image is eroded iteratively in (c), (d), (e) and (f). This erosion leads to shrink the coin surfaces. In (f), it is clear that each coin is represented by smaller dots without connected to others, mostly.