TDT4195: Visual Computing Fundamentals

Image Processing - Assignment 2 Report

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1 Segmentation and Morphology Theory

(1a.)

In mathematical morphology, opening is a morphological operation that involves the sequential application of erosion followed by dilation on an input image while closing is an operation that consists of the sequential application of dilation followed by erosion on an input image.
Applying opening and closing operations multiple times on an image iteratively refines its details and eliminates smaller elements while smoothing and enhancing the connectivity of its main features.

(1b.)

Smoothing an image before edge detection helps in noise reduction, enhances edge detection by reducing high-frequency intensity variations, eliminates small details, and improves the localization of edges.

(1c.)

Hysteresis thresholding separates edge pixels into strong and weak categories by employing two threshold values: a low threshold and a high threshold. Pixels with a gradient magnitude above the high threshold are considered strong edge pixels, whereas those with a gradient magnitude between the low and high thresholds are labeled as weak edge pixels. The final edge map retains the strong edge pixels, while the weak edge pixels are either kept or discarded depending on whether they are connected to a strong edge pixel or not.
Furthermore, the choice of the low and high threshold values affects the quality of the final edge map produced. Choosing a lower value for the low threshold will include more weak edges, while a higher value for the high threshold will exclude more strong edges.

(1d.)

Hysteresis thresholding helps to eliminate unwanted spurious edges caused by noise by removing weak edges that are not connected to the strong edges and thereby preserving continuous edges.

(1e.)

For a dilation operation on the binary image using the given structuring element whose reference pixel is indicated by a black circle, the vertical neighbors (up and down) of a pixel that coincides with the reference pixel and whose value is 1 turns to 1

0	0	1	1	1	0	0
0	1	0	0	0	1	0
1	0	0	0	0	0	1
1	0	1	0	1	0	1
1	0	0	0	0	0	1
0	1	0	0	0	1	0
0	0	1	1	1	0	0

$\oplus$

1
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1

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0	1	1	1	1	1	0
1	1	1	1	1	1	1
1	1	1	0	1	1	1
1	0	1	0	1	0	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1
0	1	1	1	1	1	0

2 Segmentation Programming

(2a.)

(a) Segmented Thumbprint (b) Segmented Shaded Rice

Figure 1: Image Segmentation using Otsu's thresholding algorithm

(2b.)

Figure 2: Segmented defect-weld image using region growing algorithm

3 Morphology Programming

(3a.)

To remove the noisy elements from the noisy image provided, I executed the following steps:

1. Performed erosion using a disk structuring element with a radius of 7 to remove noisy elements around the triangle. This operation shrunk the size of the triangle and also expanded the holes within the triangle.
2. Therefore, to fill these expanded holes, I applied dilation with a disk structuring element of radius 13. This action successfully filled the holes but enlarged the triangle.
3. Finally, to resize the triangle to its original dimensions in the initial image, I conducted another erosion operation, this time using a disk structuring element with a radius difference of $(13 - 7)$ (i.e., the difference of the disk radii used for dilation and erosion in the previous steps).

The process's visual representation can be seen in Figure 3 below while the final almost noise-free version of the given image is shown in 4.

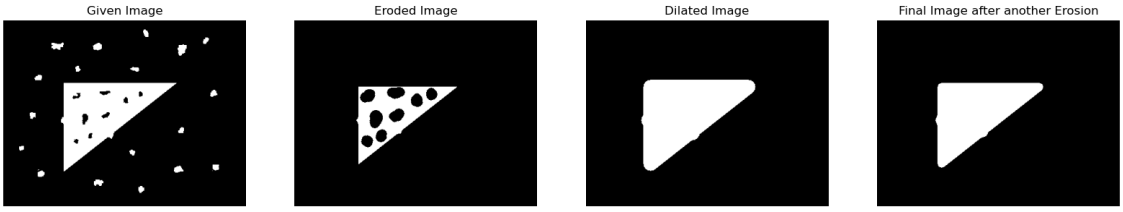

Figure 3: Morphological noise removal process for the given noisy binary image

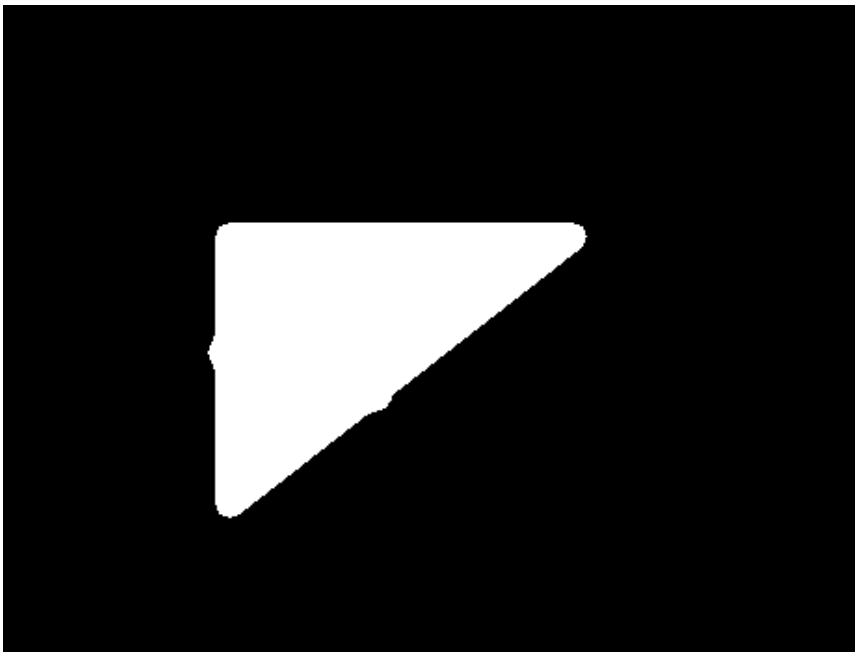

Figure 4: An almost noise-free version of the given noisy image after morphological operations.

(3b.)

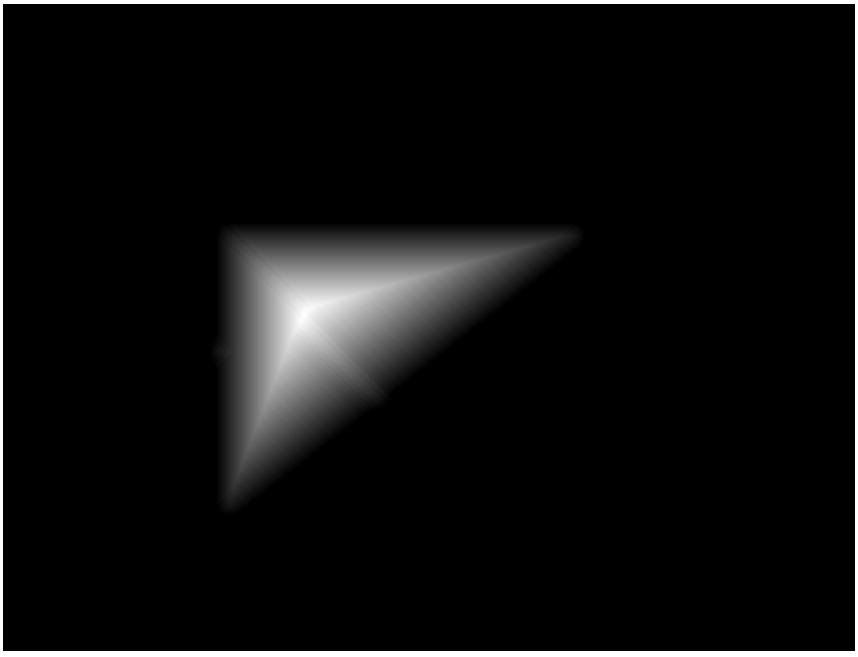

Figure 5: A distance transform of the filtered binary image using chessboard distance.

(3c.)

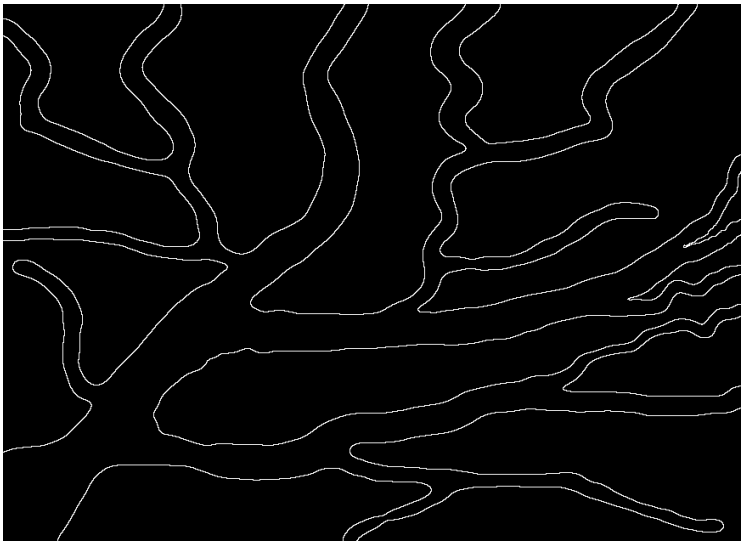

Figure 6: Blood vessels boundary.

(3d.)

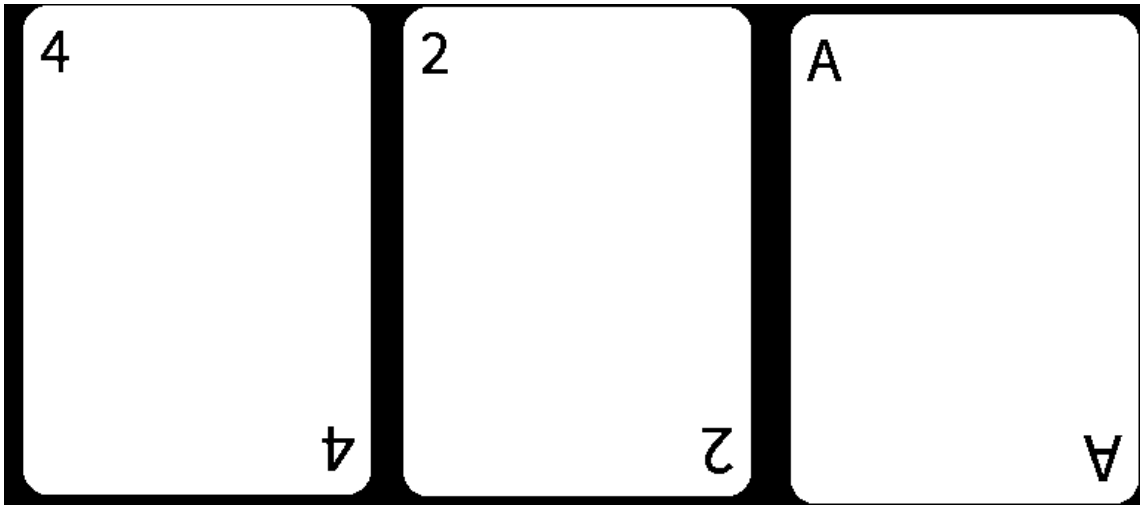

Figure 7: Filled cards image