

## Exercise Sheet 2

### 1 CCD Camera

Let a CCD camera chip have a resolution of  $1024 \times 1024$  pixels. A  $20 \times 20$  cm area featuring a regular pattern of black and white vertical lines is then captured by the camera.

1. What is the maximum number of vertical lines that can be captured by the camera?
2. What is the minimum line with up to which the pattern can be captured correctly?

### 2 Neighbourhoods

Figure 1 shows a yellow and a red area. Depending on the definition of adjacency we are looking at either one or two objects.

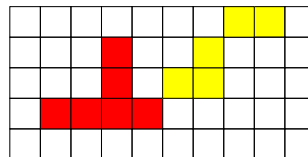


Figure 1: Two objects.

- Are the two areas 4-adjacent?
- Are they 8-adjacent?
- Are they  $m$ -adjacent?

### 3 Diagonal Path Length

Figure 2 depicts a red triangle on a white background.

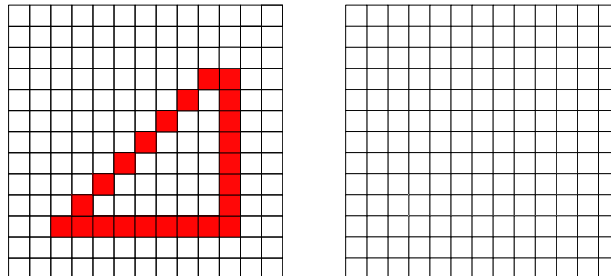


Figure 2: Diagonal path.

1. Sketch a unique  $m$ -connected path that connects all pixels of the triangle?
2. Compute the Euclidean length  $U_m$  of the path you just drew.
3. Remove some of the red pixels in such way that all neighbourhoods are now 8-connected. Sketch your result in the blank area of Figure 2.
4. What is the Euclidean length  $U_r$  of the 8-connected path?

### 4 Distance Metrics

Given are two points  $x = (3, 8)$  and  $y = (15, 5)$ . Compute their Euclidean, Manhattan and Chessboard distance.

### 5 Image Statistics

Given are two grayscale images

$$x = \begin{bmatrix} 50 & 40 & 80 \\ 20 & 70 & 90 \\ 30 & 60 & 100 \end{bmatrix}, \quad y = \begin{bmatrix} 10 & 20 & 20 \\ 10 & 0 & 20 \\ 10 & 10 & 20 \end{bmatrix}$$

For each of the images compute both mean  $\mu$  and standard deviation  $\sigma$ .

## Solutions

### Exercise 1

1. Number of lines: 512
2. Minimum distance:  $195 \mu\text{m}$

### Exercise 2

No, yes, yes

### Exercise 3

- 1.

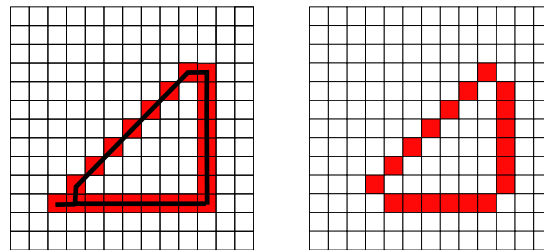


Figure 3: Triangle—solution.

2.  $U_m = \frac{12\sqrt{2}}{2} + 17 = 24.845$
3. See Figure 3.
4.  $U_r = 9\sqrt{2} + 10 \cdot 1 = 22.73$

### Exercise 4

- Euclidean: 12.37 pixels
- Manhattan: 15 pixels
- Chessboard: 12 pixels

### Exercise 5

- $\mu_x = 60.0, \sigma_x = 27.38$
- $\mu_y = 13.3, \sigma_y = 7.07$