

7 Exercises

Exercise 1: Perform *logical* operations including OR, AND, NOT, XOR on two binary images.

Note: OpenCV provides the essential functions

1. `cv2.bitwise_and(b1,b2,mask=None)`
2. `cv2.bitwise_not(b1,b2,mask=None)`
3. `cv2.bitwise_xor(b1,b2,mask=None)`
4. `cv2.bitwise_or(b1,b2,mask=None)`

Exercise 2: Perform morphological operations on the input image.

1. $f \ominus g$ (Erosion)
2. $f \oplus g$ (Dilate)
3. $f - (f \ominus g)$ (Boundary extraction)
4. $(f \oplus g) - (f \ominus g)$ (Morphological Gradient)
5. $(f \ominus g) \oplus g$ (Closing)
6. $(f \oplus g) \ominus g$ (Opening)
7. $f - ((f \ominus g) \oplus g)$ (Top - Hat)
8. $((f \oplus g) \ominus g) - f$ (Black - Hat)

Create the structuring elements g including *rect*, *cross*, *ellipse*, *diamond*, *square*

Hint: OpenCV provides the essential functions

1. `cv2.dilate(bw, kernel, iterations = 1)`
2. `cv2.erode(bw, kernel, iterations = 1)`
3. `cv2.getStructuringElement(cv2.MORPH_RECT,(3,3), iterations = 1)`
4. `cv2.morphologyEx(bw,cv2.MORPH_OPEN, kernel, iterations = 1)`

Exercise 3: Create the binary images and perform on the structure element S with Erosion and Dilation operators respectively.

$$S = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Exercise 4: Implement Sharper algorithm and show a school crossing road sign (*ahead.png*) taken by an out-of-focus camera. Design your structuring element B . Return the resulting image is obtained after 10 iterations. Comment on which features in the image have been made sharper.

Algorithm 1 Sharper algorithm

```
1: procedure SP-ALG( $N$  is the number of iteration,  $I$  is the input image)
2:   for each  $i \leftarrow 0$  to  $N - 1$  do
3:     Find  $I_d = I \oplus B$  (Dilation)
4:     Find  $I_e = I \ominus B$  (Erosion)
5:     Compute  $\hat{I} \leftarrow \frac{I_d + I_e}{2}$ 
6:     if  $I \geq \hat{I}$  then
7:        $I \leftarrow I_d$ 
8:     else
9:        $I \leftarrow I_e$ 
10:    end if
11:  end for
12: end procedure
```

8 References

1. R. C. Gonzalez, R. E. Woods. Digital Image Processing. New Jersey, Prentice Hall, 2002.
2. T. Acharya. Image Processing Principles and Applications. New York, Wiley & Son, 2005
3. I.T. Young, J.J. Gerbrands, L.J. van Vliet. Fundamentals of Image Processing, Delft University of Technology, 1998.