

## 5 Exercises

**Exercise 1:** Write a program to implement Sobel operator at  $45^\circ$

**Exercise 2:** Write a program to implement Prewitt operator at  $135^\circ$

**Exercise 3:** Write a program to implement Scharr operator

$$S_x = \begin{bmatrix} 3 & 0 & -3 \\ 10 & 0 & -10 \\ 3 & 0 & -3 \end{bmatrix}, S_y = \begin{bmatrix} 3 & 10 & 3 \\ 0 & 0 & 0 \\ -3 & -10 & -3 \end{bmatrix}$$

**Exercise 4:** Write a program to implement Compass operator (the orientation of 45 degrees in eight directions)

$$\begin{aligned} C_0 &= \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, C_1 = \begin{bmatrix} -2 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & 1 & 2 \end{bmatrix} \\ C_2 &= \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, C_3 = \begin{bmatrix} 0 & -1 & -2 \\ 1 & 0 & -1 \\ 2 & 1 & 0 \end{bmatrix} \\ C_4 &= \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}, C_5 = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & -1 & -2 \end{bmatrix} \\ C_6 &= \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}, C_7 = \begin{bmatrix} 0 & 1 & 2 \\ -1 & 0 & 0 \\ -2 & -1 & 0 \end{bmatrix} \end{aligned}$$

**Exercise 5:** Write a program to apply a thresholding and Sobel filter on a given image.

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**Algorithm 2** TS filtering

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1: procedure TS-ALG( $I$  is a gray image,  $\tau$  is the predefined thresholding)
2:    $I_e$  is initialized as the same shape  $I$ .
3:   Loop over all non-boundary pixels on  $I$  by the Sobel discrete operator.
4:   Compute  $\Delta I_x$  and  $\Delta I_y$ 
5:   Compute magnitude  $|\Delta I|$  and direction of edges  $\Theta$ 
6:   if  $|\Delta I| > \tau$  then
7:      $I_e(x, y) = 1$ .
8:   else
9:      $I_e(x, y) = 0$ 
10:  end if
11: end procedure

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**Exercise 6:** Write a program to implement *Laplacian operator*.

**Exercise 7:** Write a program to implement *Laplacian of Gaussian (LoG) operator*.

**Exercise 8:** Write a program to detect how many shapes and colors in a given image and put text on objects with object information (e.g color, shape, and bounding boxes).

**Exercise 9:** Compare your results when detect objects among Sobel, Prewitt, Canny.

**Exercise 10:** Write a program to detect lanes in a given image. Which method is good for this problem?

## 6 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.