

Computer-vision-Homework 9

General Edge Detection

Due date : 14 Dec 2021

Programming language: python 3.9.9

Import lib:

- Opencv: to read and write the image file
- Numpy: to work with the arrays
- Math: to deal with some calculations.

Original image: lena.bmp

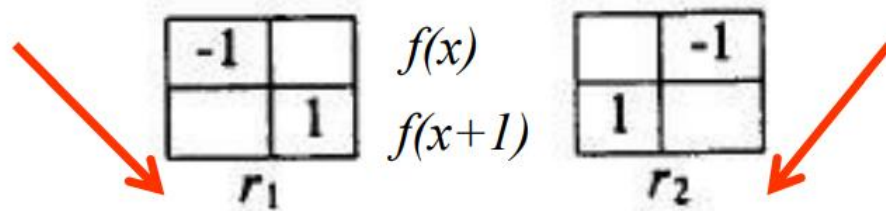
```
[512(width),512(height),1channel(cv2.IMREAD_GRAYSCALE)]
```

Code explanation:

(a) : Robert's Operator: 30

According to the formula, we can obtain the gradient magnitude by the applying two 2*2 mask and calculate it as the following function.

$$f'(x) \approx f(x+1) - f(x)$$



$$\text{gradient magnitude: } \sqrt{r_1^2 + r_2^2}$$

(b) : Prewitt's Edge Detector: 24

(c) : Sobel's Edge Detector: 38

(d) : Frei and Chen's Gradient Operator: 30

(b)(c)(d) has similar function with the only difference, which is the mask pattern.

Prewitt operator (ppt p.82)

$$f'(x) \approx f(x+1) - f(x-1)$$

Threshold=24

-1	-1	-1
1	1	1

p_1

$f(x-1)$

-1		1
-1		1
-1		1

$f(x+1)$

p_2

$$\text{gradient magnitude: } \sqrt{p_1^2 + p_2^2}$$

Sobel operator (ppt p.84)

$$f'(x) \approx f(x+1) - f(x-1)$$

Threshold=38

-1	-2	-1
1	2	1

s_1

$f(x-1)$

-1		1
-2		2
-1		1

$f(x+1)$

s_2

$$\text{gradient magnitude: } \sqrt{s_1^2 + s_2^2}$$

Frei and Chen gradient operator (ppt p.87) Threshold=30

$f(x-1)$	<table border="1"><tr><td>-1</td><td>$-\sqrt{2}$</td><td>-1</td></tr><tr><td></td><td></td><td></td></tr><tr><td>1</td><td>$\sqrt{2}$</td><td>1</td></tr></table>	-1	$-\sqrt{2}$	-1				1	$\sqrt{2}$	1	<table border="1"><tr><td>-1</td><td></td><td>1</td></tr><tr><td>$-\sqrt{2}$</td><td></td><td>$\sqrt{2}$</td></tr><tr><td>-1</td><td></td><td>1</td></tr></table>	-1		1	$-\sqrt{2}$		$\sqrt{2}$	-1		1
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$f(x+1)$	<table border="1"><tr><td>-1</td><td>$-\sqrt{2}$</td><td>-1</td></tr><tr><td></td><td></td><td></td></tr><tr><td>1</td><td>$\sqrt{2}$</td><td>1</td></tr></table>	-1	$-\sqrt{2}$	-1				1	$\sqrt{2}$	1	<table border="1"><tr><td>-1</td><td></td><td>1</td></tr><tr><td>$-\sqrt{2}$</td><td></td><td>$\sqrt{2}$</td></tr><tr><td>-1</td><td></td><td>1</td></tr></table>	-1		1	$-\sqrt{2}$		$\sqrt{2}$	-1		1
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$-\sqrt{2}$		$\sqrt{2}$																		
-1		1																		
	f_1	f_2																		

gradient magnitude: $\sqrt{f_1^2 + f_2^2}$ $f'(x) \approx f(x+1) - f(x-1)$

(e) Kirsch's Compass Operator: 135

(f) Robinson's Compass Operator: 43

(e)(f) has similar function with the only difference, which is the mask pattern.

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-3	5	5																																					
k_4	k_5	k_6	k_7																																				

gradient magnitude: $\max_{n,n=0,\dots,7} k_n$

Mask of kirsch's Compass Operator.

-1		1
-2		2
-1		1

r_0

	1	2
-1		1
-2	-1	

r_1

1	2	1
-1	-2	-1

r_2

2	1	
1		-1
	-1	-2

r_3

1		-1
2		-2
1		-1

r_4

	-1	-2
1		-1
2	1	

r_5

-1	-2	-1
1	2	1

r_6

-2	-1	
-1		1
	1	2

r_7

gradient magnitude: $\max_{n,n=0,\dots,7} r_n$

Mask of Robinson Compass Operator

(g) Nevatia-Babu 5x5 Operator: 12500

Nevatia-Babu operator has the biggest mask as the following image shows.

gradient magnitude: $\max_{n,n=0,\dots,5} N_n$

100	100	100	100	100
100	100	100	100	100
0	0	0	0	0
-100	-100	-100	-100	-100
-100	-100	-100	-100	-100

0°

100	100	100	32	-100
100	100	92	-78	-100
100	100	0	-100	-100
100	78	-92	-100	-100
100	-32	-100	-100	-100

60°

-100	32	100	100	100
-100	-78	92	100	100
-100	-100	0	100	100
-100	-100	-92	78	100
-100	-100	-100	-32	100

-60°

100	100	100	100	100
100	100	100	78	-32
100	92	0	-92	-100
32	-78	-100	-100	-100
-100	-100	-100	-100	-100

30°

-100	-100	0	100	100
-100	-100	0	100	100
-100	-100	0	100	100
-100	-100	0	100	100
-100	-100	0	100	100

-90°

100	100	100	100	100
-32	78	100	100	100
-100	-92	0	92	100
-100	-100	-100	-78	32
-100	-100	-100	-100	-100

-30°

By extending the borders and calculate the image with the masks and threshold mentioned above, we can get the final image as below.

- (a) Robert's Operator: 30



- (b) Prewitt's Edge Detector: 24



- (c) Sobel's Edge Detector: 38



- (d) Frei and Chen's Gradient Operator: 30



- (e) Kirsch's Compass Operator: 135



- (f) Robinson's Compass Operator: 43



- (g) Nevatia-Babu 5x5 Operator: 12500

