Hw4_Edge Detection

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1 Technical description

(1) Sobel

下方為Sobel在spatial domain的mask

−1	−2	−1	−1	0	1
0	0	0	−2	0	2
1	2	1	−1	0	1

Sobel

這次使用兩張mask分別對三張test image 做convolution

$$\mathbf{G_x} = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} * \mathbf{A} \quad \text{and} \quad \mathbf{G_y} = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * \mathbf{A}$$

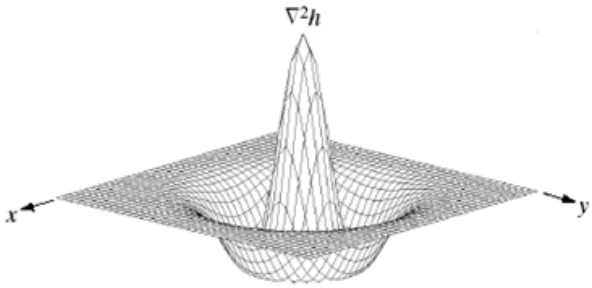
Gx = [f(x+1,y-1)+2*f(x+1,y)+f(x+1,y+1)] - [f(x-1,y-1)+2*f(x-1,y)+f(x-1,y+1)]

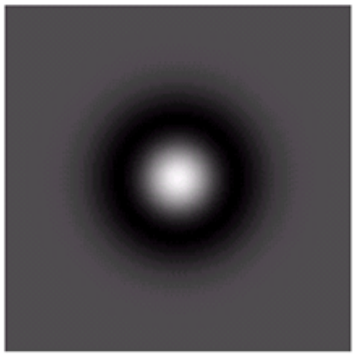
Gy = [f(x-1,y-1) + 2f(x,y-1) + f(x+1,y-1)] - [f(x-1, y+1) + 2*f(x,y+1)+f(x+1,y+1)

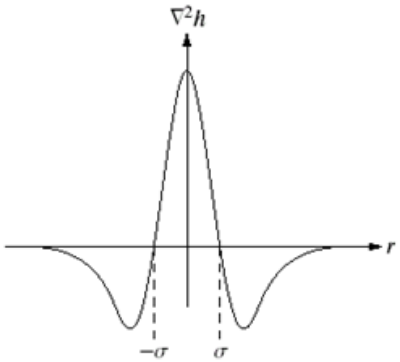
(2) LoG

下方為這一次LoG在spatial domain的mask

LoG可以被用來增加邊緣和其他細節的可見性







0	0	−1	0	0
0	−1	−2	−1	0
−1	−2	16	−2	−1
0	−1	−2	−1	0
0	0	−1	0	0

a b
c d

FIGURE 10.14 Laplacian of a Gaussian (LoG). (a) 3-D plot. (b) Image (black is negative, gray is the zero plane, and white is positive). (c) Cross section showing zero crossings. (d) 5 × 5 mask approximation to the shape of (a).

```
clc;
clear all;
% 初始化
img_array=cell(1,3);
img_array{1} = imread('image1.jpg');
img_array{2} = imread('image2.jpg');
img_array{3} = imread('image3.jpg');

for i=1:3

% Sobel
% x方向
mask=[-1,-2,-1;0,0,0;1,2,1];
I_Sobel_X = convolution(img_array{i},3,mask);
% y方向
mask=[1,0,-1;2,0,-2;1,0,-1];
I_Sobel_Y = convolution(img_array{i},3,mask);

I_Sobel=I_Sobel_X+I_Sobel_Y;

% LoG
mask=[0,0,-1,0,0;0,-1,-2,-1,0;-1,-2,16,-2,-1;0,-1,-2,-1,0;0,0,-1,0,0];
I_LoG = convolution(img_array{i},5,mask);

% 結果
figure;
sgtitle('edge detection');
subplot(1,3,1),imshow(img_array{i});title('Original image');
subplot(1,3,2),imshow(I_Sobel);title('Sobel');
subplot(1,3,3),imshow(I_LoG);title('LoG');
end
```

convolution function的參數分別為(原圖,mask size,mask)

根據mask size的大小對原圖做convolution

將產生的結果放在output

```
function  output = convolution(I,m_size,mask)
[m,n]=size(I);
I=im2double(I);
output=zeros(size(I));
Start = ceil(m_size/2);
End = floor(m_size/2);
for i = Start : m - End
    for j = Start : n - End
        tmp=mask.*I(i-End:i+End,j-End:j+End);
        output(i-End:i+End,j-End:j+End)=sum(tmp(:));
    end
end
output=im2uint8(output);
end
```

2 Experimental results

edge detection

Original image

Sobel

LoG

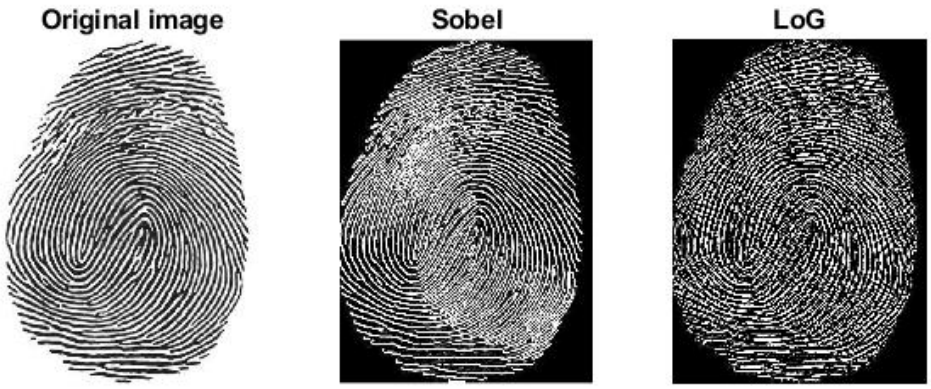
edge detection

Original image

Sobel

LoG

edge detection



3 Discussions

(1)sobel

這次使用x方向和y方向的sobel mask 對原圖做convolution，之後再相加，比起單方向更能凸顯圖片細節，例如下面這張圖片，

產生的結果會比單方向更有可讀性，也可以用diagonal directions的mask

a b
c d

FIGURE 10.10
(a) Original image. (b) $|G_x|$, component of the gradient in the x-direction. (c) $|G_y|$, component in the y-direction. (d) Gradient image, $|G_x| + |G_y|$.

(1)LoG

The purpose of the Gaussian function in the LoG formulation is to smooth the image, and the purpose of the Laplacian operator is to provide an image with zero crossings used to establish the location of edges. Smoothing the image reduces the effect of noise and, in principle, it counters the increased effect of noise caused by the second derivatives of the Laplacian.

從上文得知先用Gaussian function對圖片進行平滑的處理，可以降低圖片中noise的影響，方便後續的拉普拉斯操作，以達到Edge Detection的效果

4 References and Appendix

老師的投影片

https://www.itread01.com/content/1546447870.html

https://zhuanlan.zhihu.com/p/92143464