

Digital Image Processing-Assignment 02

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I. 實驗說明

調整 window size, σ , threshold 參數，觀察是否有改變。

- window size: 3,5,7
- σ : 0.1, 0.3, 0.5, 0.7, 0.9
- threshold: 0, 10, 20, 30, 40, 50
- 圖片: lena, headCT

II. 程式碼

```
1 % read image and convert to grayscale
2 im = imread('lena.tif');
3 im(:,:,4) = [];
4 grayIm = rgb2gray(im);
5 grayIm2 = imread('headCT.tif');
6 grayIm3 = imread('dentalXray.tif');
7
8 % call MarrHildreth algorithm
9 MarrHildreth(grayIm, "lena");
10 MarrHildreth(grayIm2, "headCT");
11 MarrHildreth(grayIm3, "dentalXray");
12
13 function MarrHildreth(grayIm, name)
14     for windowSz = 3:2:7
15         for sigma = 0.1:0.2:0.9
16             for threshold = 0:10:50
17                 h_filter = Laplacian_mask(
18                     (windowSz,sigma);
19                 grayIm2 = filter2(
20                     h_filter,grayIm);
21                 [Gmag,Gdir] =
22                     Gradient_magnitude(
23                         grayIm2);
24                 resIm = Zero_crossing(
25                     Gmag,Gdir,threshold);
26                 imwrite(resIm, name +
27                     windowSz + "_" + sigma
28                     + "_" + threshold +
29                     ".png");
30             end
31         end
32     end
33
34 % obtain gradient magnitude and direction
```

```
28 function [Gmag,Gdir] = Gradient_magnitude
29     (im)
30     [Gmag,Gdir] = imgradient(im,'prewitt'
31     );
32
33 % returns a rotationally symmetric
34 % Gaussian lowpass filter
35 function h = Laplacian_mask(hsize,sigma)
36     h = fspecial('log',hsize,sigma);
37 end
38
39 function im = Zero_crossing(Gmag,Gdir,
40     threshold)
41     dir = [-1,0 ; 1 0 ; 0 1; 1 0];
42     [sz1,sz2] = size(Gmag);
43     im = zeros(sz1, sz2);
44     for i = 1:sz1
45         for j = 1:sz2
46             cnt1 = 0; % the number of
47                 point has difference >
48                 threshold
49             cnt2 = 0; % the number of
50                 point show different sign
51                 with (i,j)
52             for k = 1:4
53                 x = i + dir(k,1);
54                 y = j + dir(k,2);
55                 % test if (x,y) is out of
56                 boundary
57                 if x < 1 || x > sz1 || y <
58                     1 || y > sz2
59                     continue
60             end
61             if abs(Gmag(i,j) - Gmag(x,
62                 y)) > threshold
63                 cnt1 = cnt1 + 1 ;
64             end
65             if Gdir(i,j) * Gdir(x,y) <
66                 0
67                 cnt2 = cnt2 + 1 ;
68             end
69         end
70     end
71     if cnt1 >= 1 && cnt2 >= 2
72         im(i,j) = 1;
73     end
74 end
```

61 end
62 end
63 end
64 end

III. 成果

A. *Lena*

原圖



Fig. 1. lena

不同的 window size: window size 越大，黑色部分就會越粗。

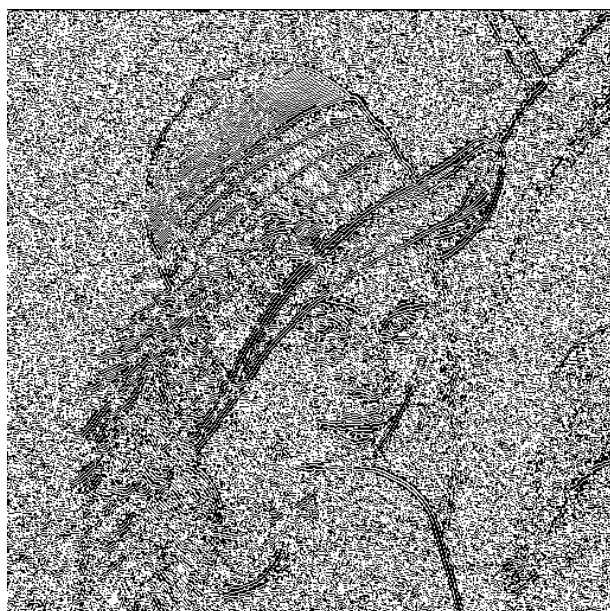


Fig. 2. window size = 3, $\sigma = 0.3$, threshold = 30

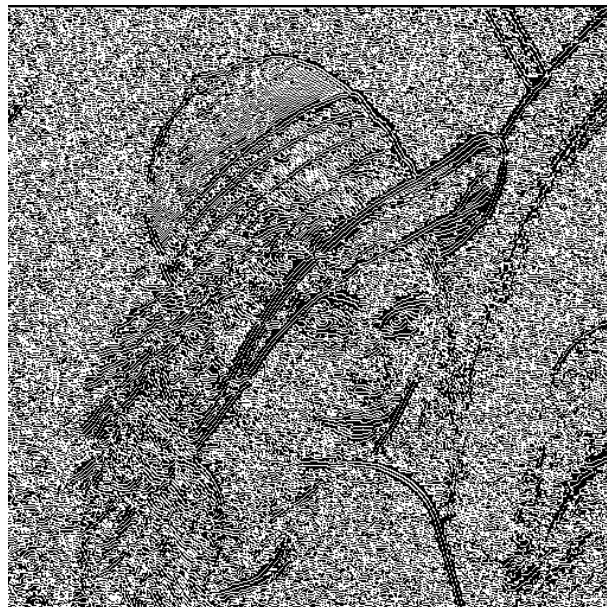


Fig. 3. window size = 5, $\sigma = 0.3$, threshold = 30



Fig. 4. window size = 7, $\sigma = 0.3$, threshold = 30

不同的 σ : σ 越大，黑白的區隔越明顯。



Fig. 5. window size = 7, $\sigma = 0.1$, threshold = 40



Fig. 7. window size = 7, $\sigma = 0.5$, threshold = 40



Fig. 6. window size = 7, $\sigma = 0.3$, threshold = 40



Fig. 8. window size = 7, $\sigma = 0.7$, threshold = 40



Fig. 9. window size = 7, $\sigma = 0.9$, threshold = 40

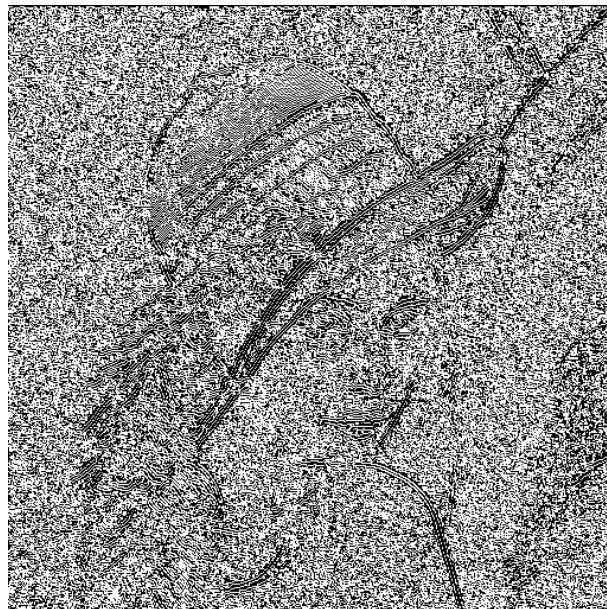


Fig. 11. window size = 3, $\sigma = 0.5$, threshold = 10

不同的 threshold: threshold 越大，白色的區域減少。

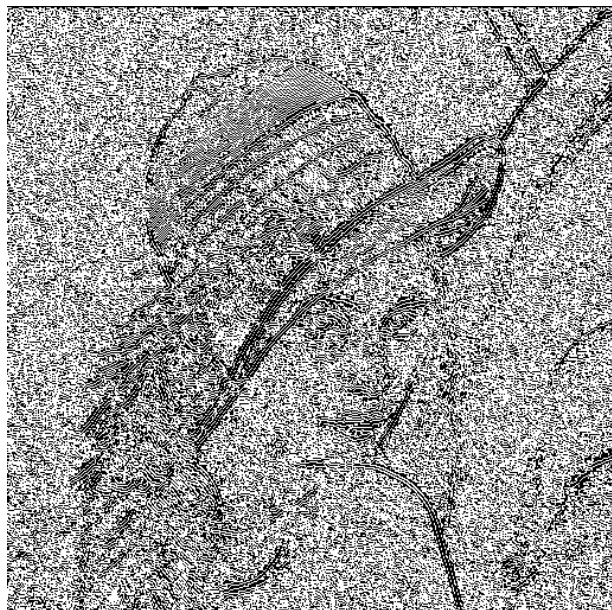


Fig. 10. window size = 3, $\sigma = 0.5$, threshold = 0

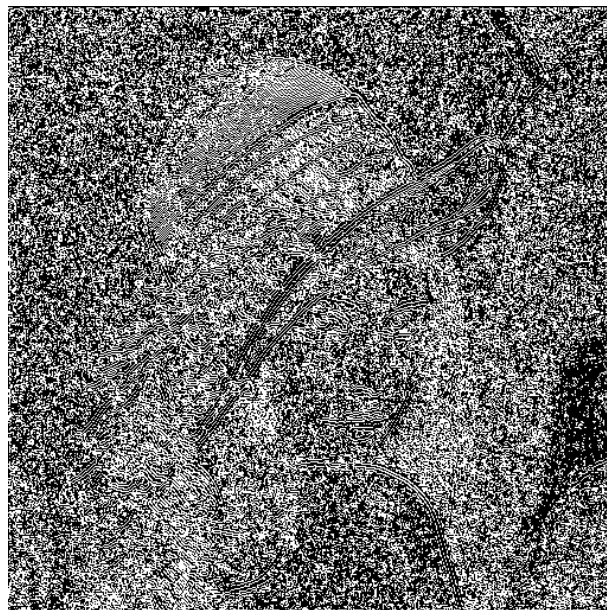


Fig. 12. window size = 3, $\sigma = 0.5$, threshold = 20



Fig. 13. window size = 3, $\sigma = 0.5$, threshold = 30



Fig. 15. window size = 3, $\sigma = 0.5$, threshold = 0

B. headCT

原圖



Fig. 14. window size = 3, $\sigma = 0.5$, threshold = 40



Fig. 16. headCT

不同的 window size: 最明顯的差異在左上角, window size = 0.3 邊界是判斷最好的, 0.5 和 0.7 時邊界消失。



Fig. 17. window size = 3, $\sigma = 0.3$, threshold = 30

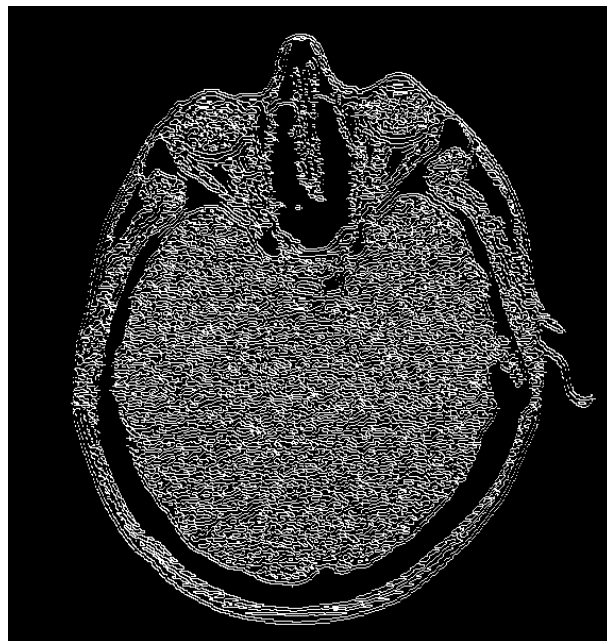


Fig. 19. window size = 7, $\sigma = 0.3$, threshold = 30

不同的 σ : 當 $\sigma \geq 0.7$ 時，圓圈中間容易被判為邊界。

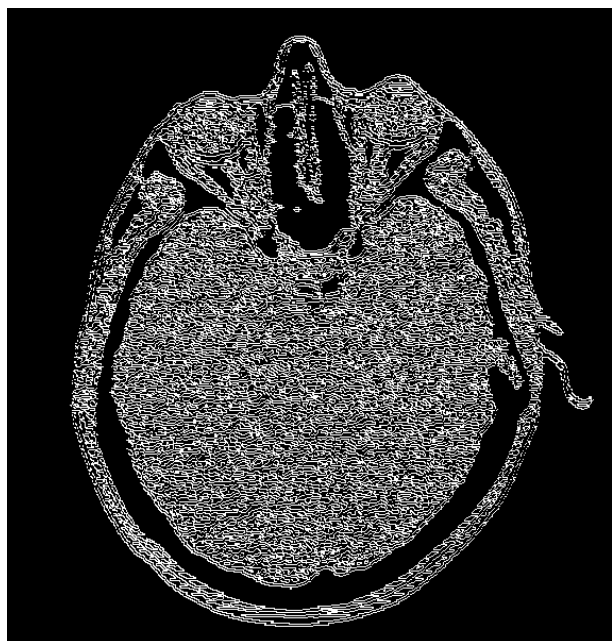


Fig. 18. window size = 5, $\sigma = 0.3$, threshold = 30



Fig. 20. window size = 7, $\sigma = 0.1$, threshold = 40



Fig. 21. window size = 7, $\sigma = 0.3$, threshold = 40



Fig. 23. window size = 7, $\sigma = 0.7$, threshold = 40

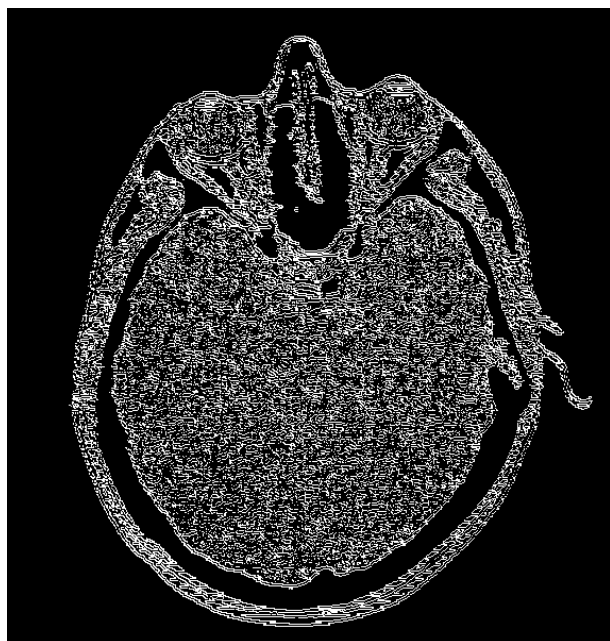


Fig. 22. window size = 7, $\sigma = 0.5$, threshold = 40



Fig. 24. window size = 7, $\sigma = 0.9$, threshold = 40

不同的 threshold: threshold 越大，白色的區域密度降低。

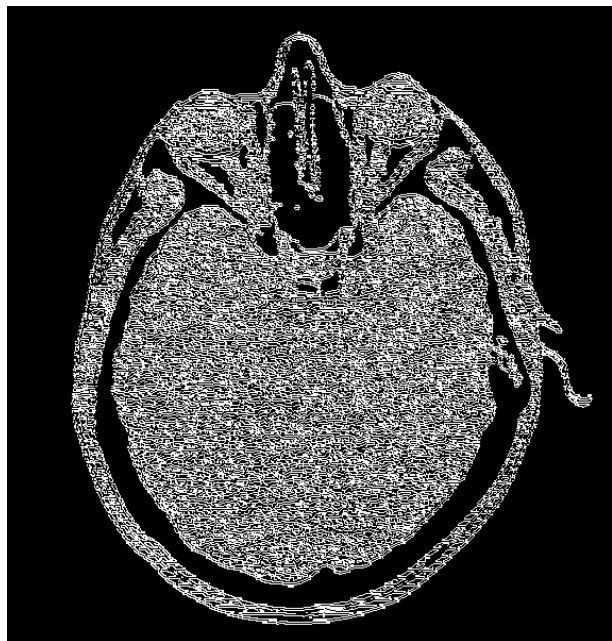


Fig. 25. window size = 3, $\sigma = 0.5$, threshold = 0

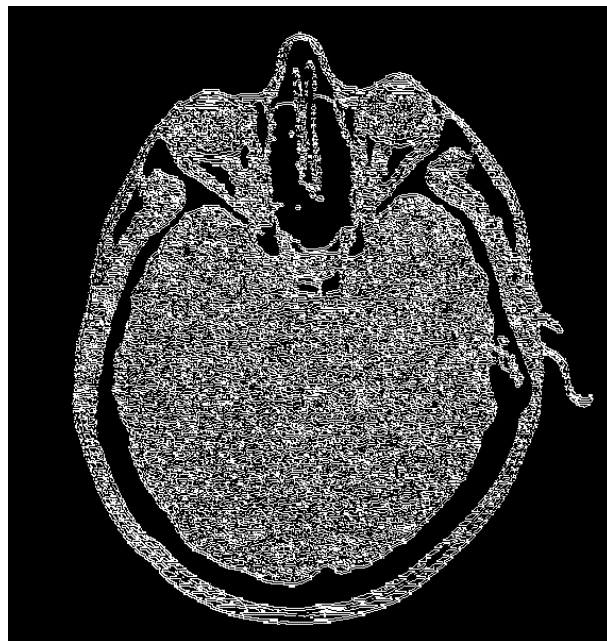


Fig. 27. window size = 3, $\sigma = 0.5$, threshold = 20



Fig. 26. window size = 3, $\sigma = 0.5$, threshold = 10

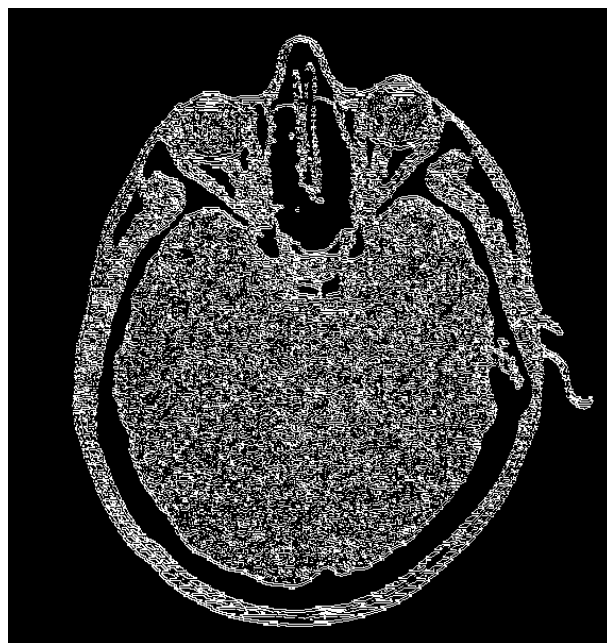


Fig. 28. window size = 3, $\sigma = 0.5$, threshold = 30

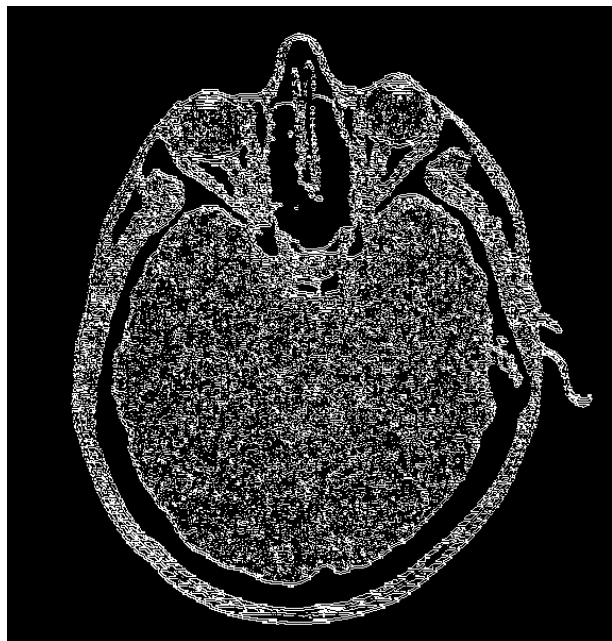


Fig. 29. window size = 3, $\sigma = 0.5$, threshold = 40

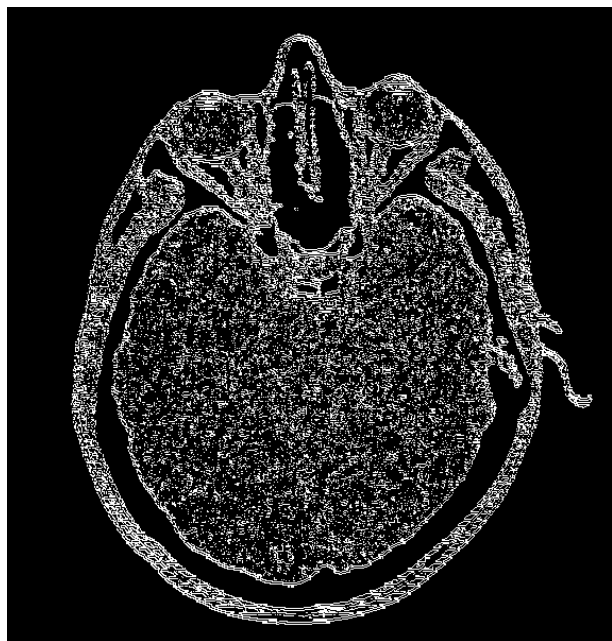


Fig. 30. window size = 3, $\sigma = 0.5$, threshold = 0

C. dentalXray

原圖

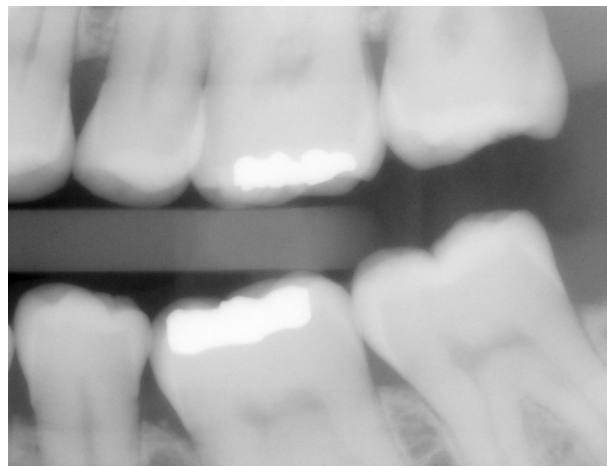


Fig. 31. dentalXray

不同的 window size: window size= 7 時邊界的輪廓較清楚。

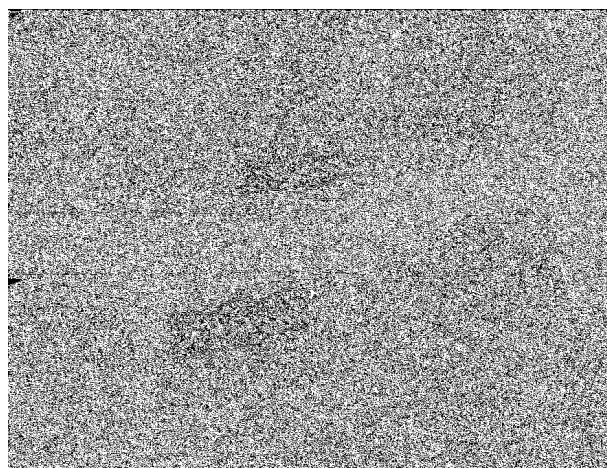


Fig. 32. window size = 3, $\sigma = 0.3$, threshold = 30

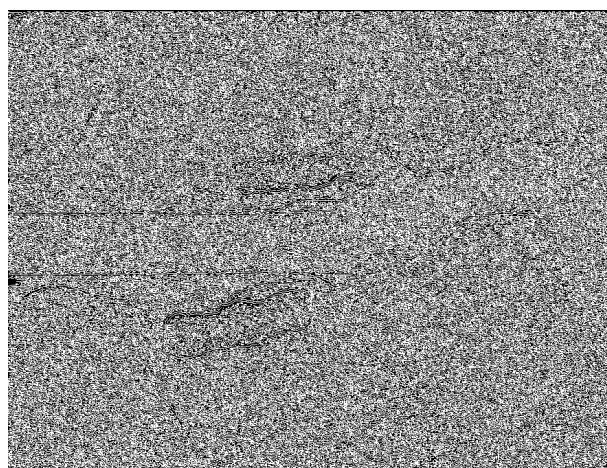


Fig. 33. window size = 5, $\sigma = 0.3$, threshold = 30

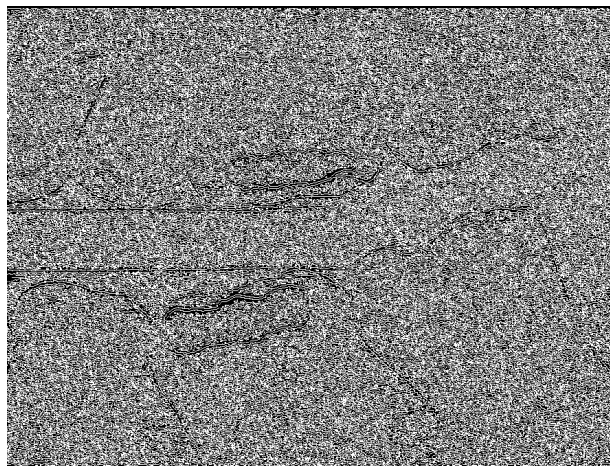


Fig. 34. window size = 7, $\sigma = 0.3$, threshold = 30

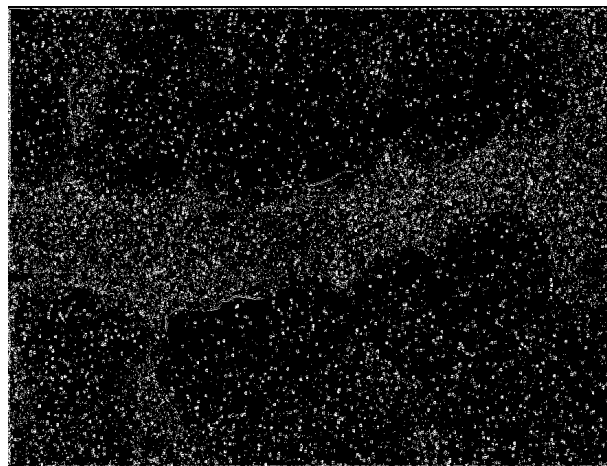


Fig. 37. window size = 7, $\sigma = 0.5$, threshold = 40

不同的 σ : $\sigma = 0.1, 0.3$ 時，可以看到較正確的邊界， $\sigma \geq 0.5$ 時，大部分的點都被判斷為邊界，效果較差。

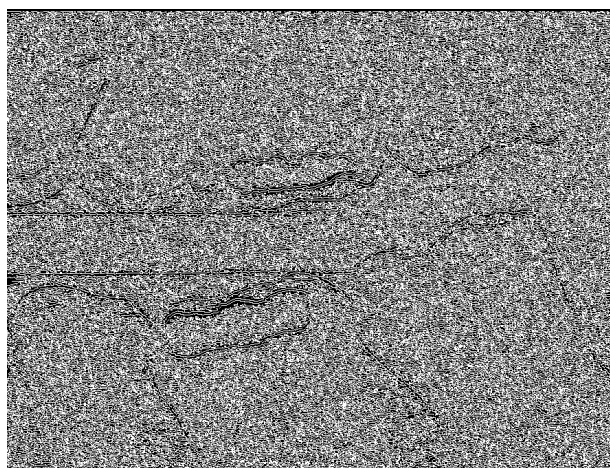


Fig. 35. window size = 7, $\sigma = 0.1$, threshold = 40

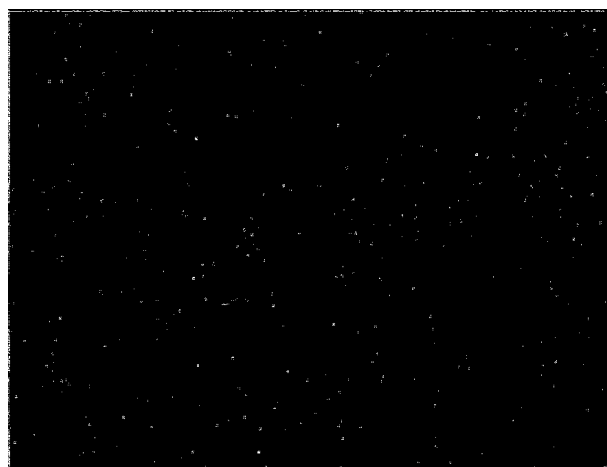


Fig. 38. window size = 7, $\sigma = 0.7$, threshold = 40

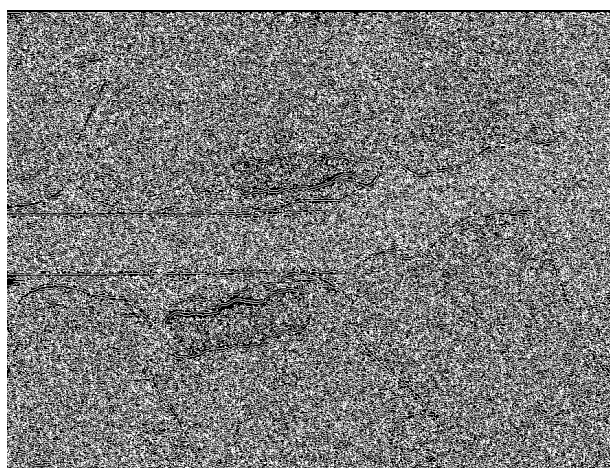


Fig. 36. window size = 7, $\sigma = 0.3$, threshold = 40



Fig. 39. window size = 7, $\sigma = 0.9$, threshold = 40

不同的 threshold: 和上述兩張圖片類似，threshold 越大，白色的區域減少。

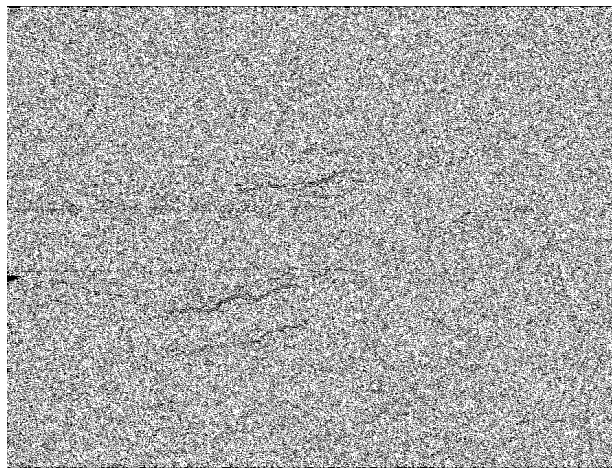


Fig. 40. window size = 3, $\sigma = 0.5$, threshold = 0

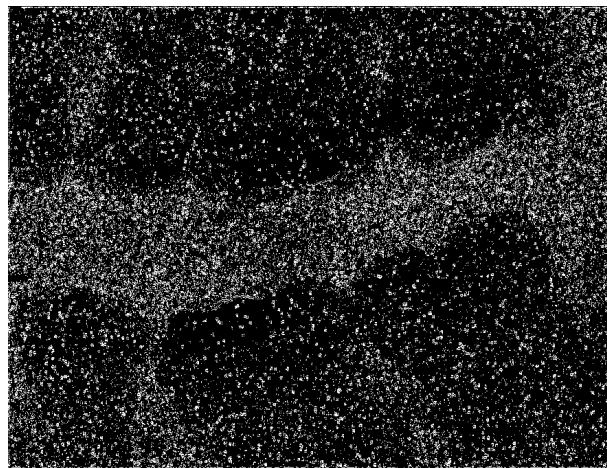


Fig. 43. window size = 3, $\sigma = 0.5$, threshold = 30

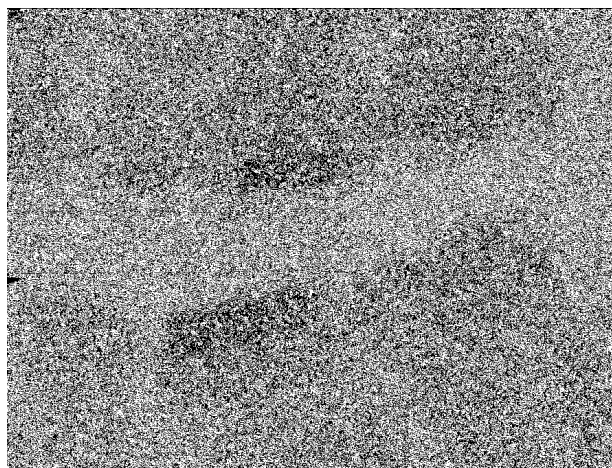


Fig. 41. window size = 3, $\sigma = 0.5$, threshold = 10

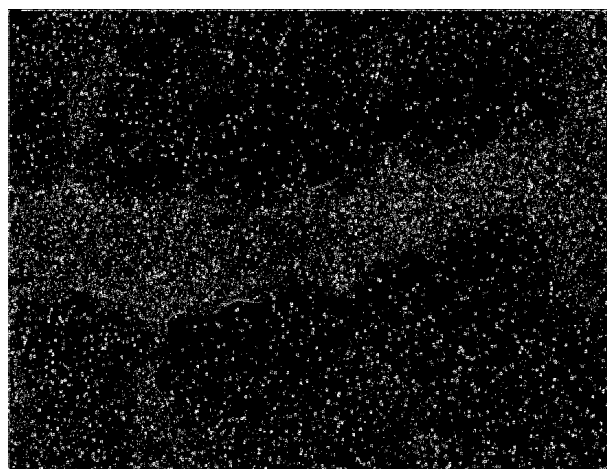


Fig. 44. window size = 3, $\sigma = 0.5$, threshold = 40

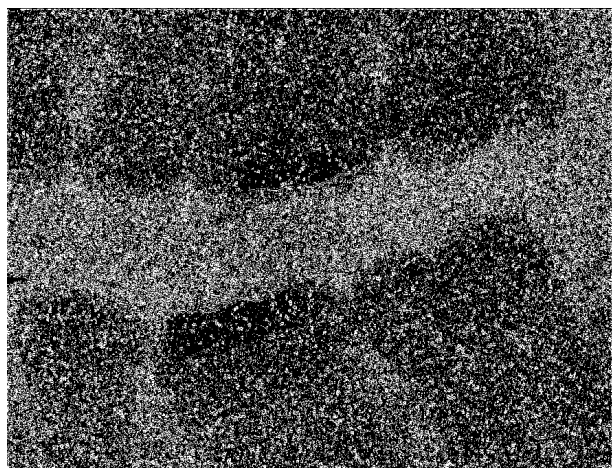


Fig. 42. window size = 3, $\sigma = 0.5$, threshold = 20

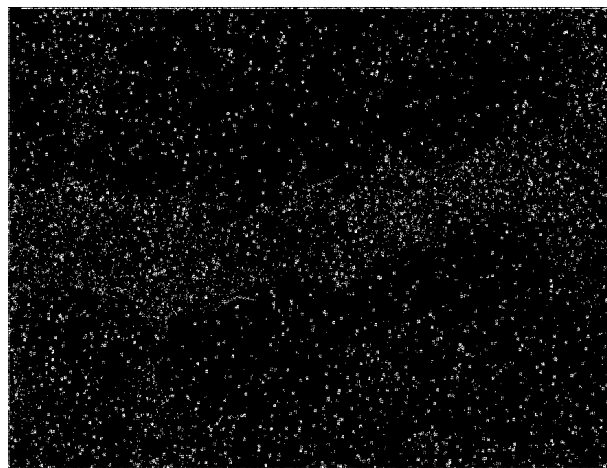


Fig. 45. window size = 3, $\sigma = 0.5$, threshold = 0

IV. 結語

不同的 window size，對每張圖片的影響不同；不同的 σ 和 threshold，會影響被判斷為邊界的比例多寡。不同

的照片適合的參數不盡相同，需要多次實驗才能找出。