許笙杰 E14075304 機械四乙

Final Project

1. 由於原影像解析度不足，因此我把影像的解析度提升為 16 倍，將影像 zero padding 到高 1024、寬 4096 像素再做 2D FFT。在處理第一張影像時，因測量時傾斜關係導致影像上方有陰影產生。為了減少陰影對分析結果的影響，我使用 adaptive thresholding 的方法將其轉換為二值化影像再進行 FFT。在分析結果中，最高點位於中點，利用第二高點到中點的距離即可得到週期。

$$\text{每 pixel 所佔 nm} = \frac{1500\ nm}{256\ pixels} = 5.8594\ nm/pixel$$

$$\text{圖形水平方向頻率 } f_x = \frac{\text{量測寬度}}{4096} \times 256$$

$$\text{圖形垂直方向頻率 } f_y = \frac{\text{量測高度}}{1024} \times 51$$

$$\text{圖形週期 } T = \frac{\text{每 pixel 所佔 nm}}{\sqrt{f_x^2 + f_y^2}}$$

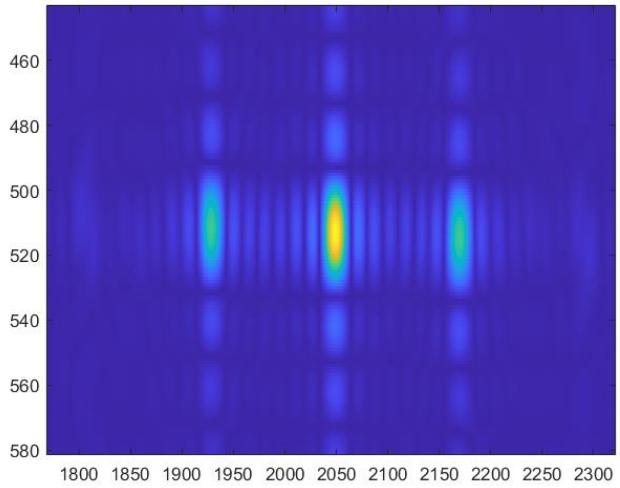

Figure (a)

中點：(2049,513)

第二高點：(2169,514)

計算得頻率 f = 7.5002 Hz

圖形週期 T = 199.9956 nm

圖形角度 θ = -0.3805˚ (CW)

與直接觀察比較: T = 200 nm, θ = -1˚ (CW)

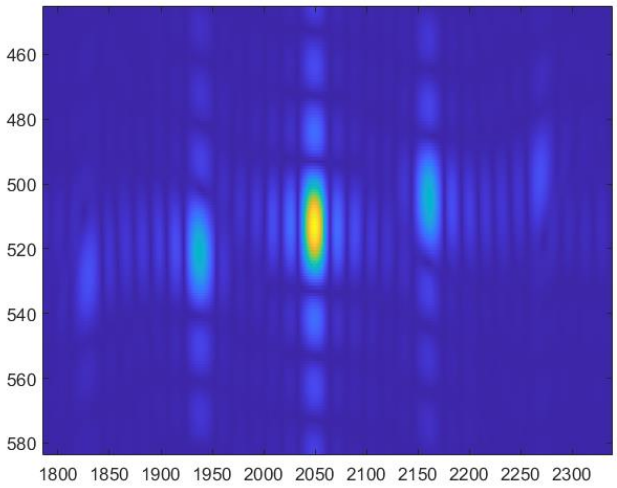

Figure (b)

中點：(2049,513)

第二高點：(2161,505)

計算得頻率 f = 7.0113 Hz

圖形週期 T = 213.9394 nm

圖形角度 θ = 3.2577° (CCW)

與直接觀察比較: T = 214 nm, θ = 5° (CCW)

```
img_w = 1500;
img_h = 300;

img1 = imread("1-1.jpg");
img1_gray = rgb2gray(img1);
fsx1 = img_w/size(img1,2);
fsy1 = img_h/size(img1,1);
T = adaptthresh(img1_gray,0.4,'ForegroundPolarity','dark');
BW = imbinarize(img1_gray,T);
F1 = fft2(BW,16*2^nextpow2(size(img1,1)),16*2^nextpow2(size(img1,2)));
figure(1);
imagesc(abs(fftshift(F1)));

img2 = imread("1-2.jpg");
img2_gray = rgb2gray(img2);
fsx2 = img_w/size(img2,2);
fsy2 = img_h/size(img2,1);
F2 = fft2(img2_gray,16*2^nextpow2(size(img2,1)),16*2^nextpow2(size(img2,2)));
figure(2);
imagesc(abs(fftshift(F2)));
```

2.

(a)

Grayscale Lenna.jpg

(b)

Sobel Lenna using $G = |G_x|+|G_y|$

Sobel Lenna after thresholding

```
img = imread("Lenna.jpg");
img_gray = rgb2gray(img);
figure(1);
imshow(img_gray);
title("Grayscale Lenna.jpg");

sobelx = [-1 0 1; -2 0 2; -1 0 1];
Gx = zeros(size(img_gray));
for i = 2:size(img_gray,1)-1
    for j = 2:size(img_gray,2)-1
        Gx(i,j) = sum(flip(flip(sobelx,1),2).*double(img_gray(i-1:i+1,j-
1:j+1)),'all');
    end
end

sobely = [-1 -2 -1; 0 0 0; 1 2 1];
Gy = zeros(size(img_gray));
for i = 2:size(img_gray,1)-1
    for j = 2:size(img_gray,2)-1
        Gy(i,j) = sum(flip(flip(sobely,1),2).*double(img_gray(i-1:i+1,j-
1:j+1)),'all');
    end
end

G = abs(Gx) + abs(Gy);
G = uint8(G);
figure(2);
imshow(G);
title("Sobel Lenna using G = |G_x|+|G_y|");

G(G<127) = 0;
figure(3);
imshow(G);
title("Sobel Lenna after thresholding");
```