tags: 影像處理

Image Processing Homework 2

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1 Technical description

圖形讀檔後都會先轉灰階，所有都使用Ideal Filter

Spatial

LaplacianSpatial 和 HighBoostSpatial ，基本一致，差別只在filter。 UnsharpMaskingFrequency部分則是用原圖減去模糊圖，我這邊是用類似於平均的方法做的。

HighBoostSpatial mask[-1,-1,-1; -1; -1,A+8,-1 ; -1,-1,-1]

```
function ImageProcessed = LaplacianSpatial(Image)
  % transform image to gray level bitmap
    [x,y] = size(Image);
    n = x * y; % n is the total number of pixels in the image
 % transform bitmap form double to int ( range:1-256 )
    for i = 1 : x
        for j = 1 : y
            ImageInt(i, j) = uint32(Image(i, j));
        end
    end
    ImageProcessed=zeros(i,j);
 % using filter [0,1,0;1,-4,1;0,1,0]
    for i=2 : x-1
        for j=2 : y-1
            ImageProcessed(i, j) = uint32(5 * ImageInt(i, j) - ImageInt(i-1, j) -
ImageInt(i, j-1) - ImageInt(i+1, j) - ImageInt(i+1, j) );
        end
    end

    ImageInt = uint8(ImageInt);
    ImageProcessed = uint8(ImageProcessed);
end
```

Frequency

都先進行FFT，三個函數基本一致差別基本只在於filter，最後都是乘積，再進行inverseFFT。

Preprocess部分會先轉double(0~1)，乘上(-1)^(x+y)，並且做padding。

FFT and filtering部分

LaplacianFrequency部分使用講義給的公式

H(i,j) = (1 + 4.*(pi.^2).*(x(i,j).^2 + y(i,j).^2));

HighBoostFrequency部分

會先計算距離算出highpass filter，且帶入公式

$$H_{hb}(u,v) = (A-1) + H_{hp}(u,v)$$

```
% distance martix
dist = zeros(len,len);
for i = 1:len
    for j = 1:len
        dist(i,j) = sqrt(x(i,j).^2 + y(i,j).^2);
    end
end

% constructing High-boost filter function
H = zeros(len,len);
for i = 1:len
    for j = 1:len
        if dist(i,j) >= 0.5  % here 0.5 is the cut-off frequency
            H(i,j) = (A-1) + 1;
        else
            H(i,j) = (A-1);
        end
    end
end
```

UnsharpMaskingFrequency部分

基本上這邊是做Ideal High Pass，UnsharpMasking並非真的做再Frequency domain上只是生成blur的方式有利用highpass filter。

PostProcess部分

基本上就將處理完的轉回spatial domain，乘上(-1)^(x+y)，剛剛在preprocess做的部分進行還原，把padding去除，轉回uint8。
LaplacianFrequency

```
function [processedImage] = LaplacianFrequency(image)

% ############ Preprocess ############

% convert to 0~1 double type value and get size
imageDouble = im2double(image);
[m,n] = size(imageDouble);

% preparing padded image variable
% size 2x of max(m,n) => make sure it wont undersampling
len = 2*max(m,n);
preProcessImage = zeros(len,len);
```

```
% Multiplying with (-1)^(x+y) and padding
for i = 1:len
    for j = 1:len
        if i <= m && j<= n
            preProcessImage(i,j) = imageDouble(i,j).*(-1).^(i + j);
        else
            preProcessImage(i,j) = 0;
        end
    end
end

% ############ FFT and filtering ############

% perform DFT to transform image to frequency domain
ImageFreq = fft2(preProcessImage);

% generate Frequency spacing for frequency response
[x,y] = freqspace(len,'meshgrid');

% constructing Laplacian enhancing filter function
H = zeros(len,len);
for i = 1:len
    for j = 1:len
        H(i,j) = ( 1 + 4.*(pi.^2).*(x(i,j).^2 + y(i,j).^2) );
    end
end

% filtering & inverse DFT
ifftImg = ifft2(ImageFreq.*H);

% ############ Postprocess ############

% Multiplying with (-1)^(x+y)
postProcessImage = zeros(len,len);
for i = 1:len
    for j = 1:len
        postProcessImage(i,j) = ifftImg(i,j).*((-1).^(i+j));
    end
end

% remove padding
out = zeros(m,n);
for i = 1:m
    for j = 1:n
        out(i,j) = postProcessImage(i,j);
    end
end

% convert to gray level(range: 0-255)
processedImage = uint8(out.*255);

end
```

2 Experimental results

origin

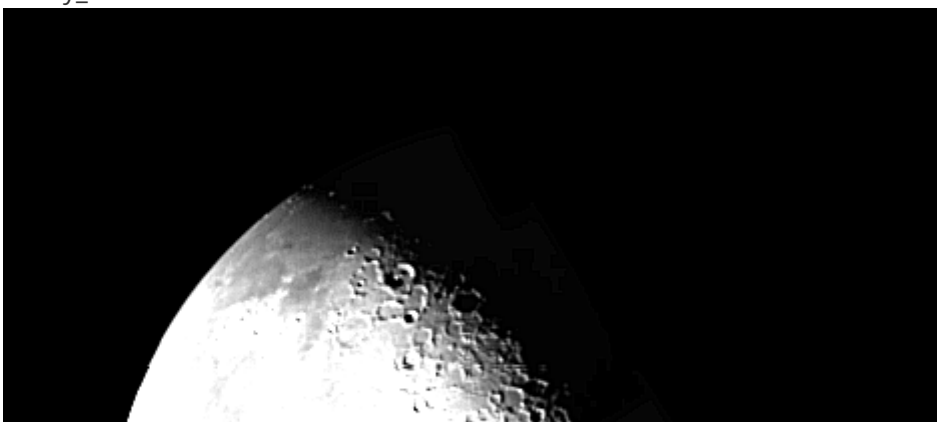
skeleton

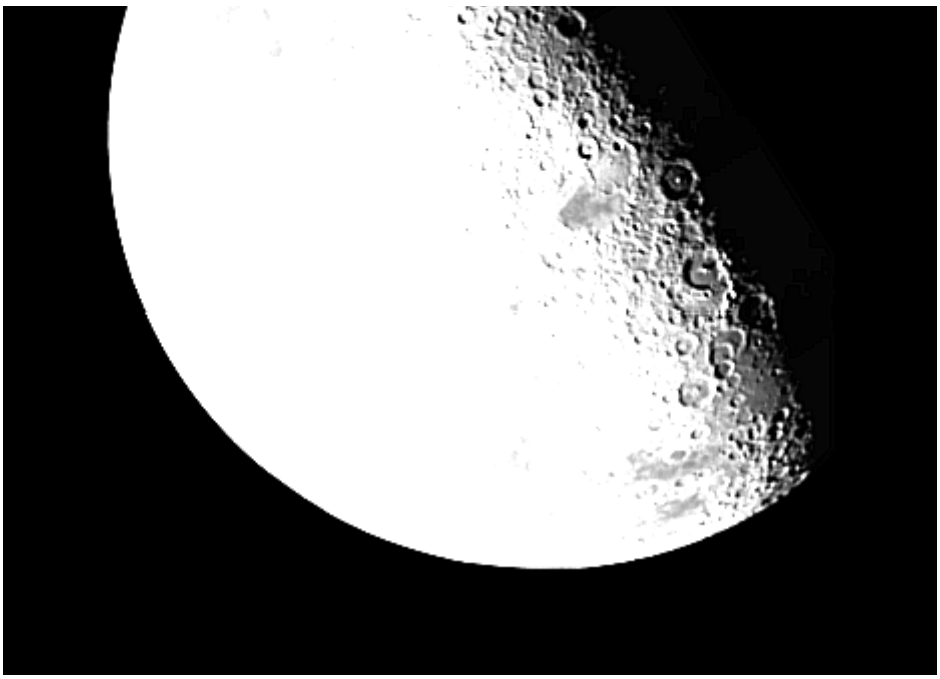
blurry_moon

HighBoostSpatial

skeleton

blurry_moon





HighBoostFrequency

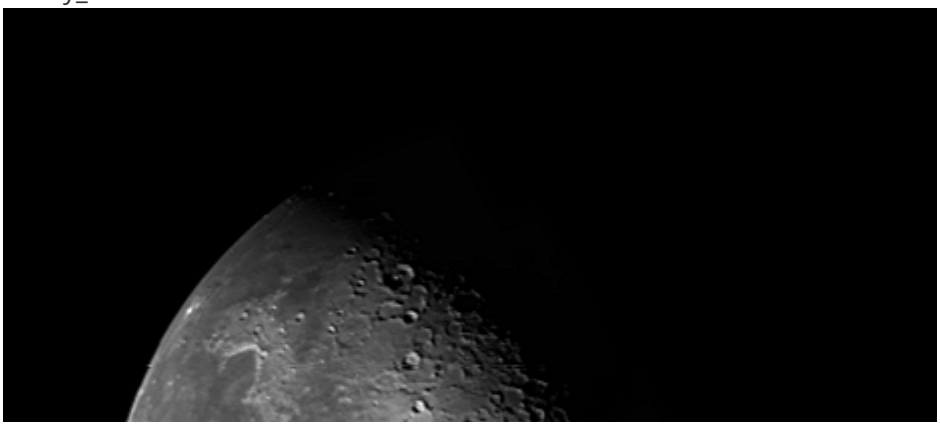
skeleton

blurry_moon

LaplacianSpatial

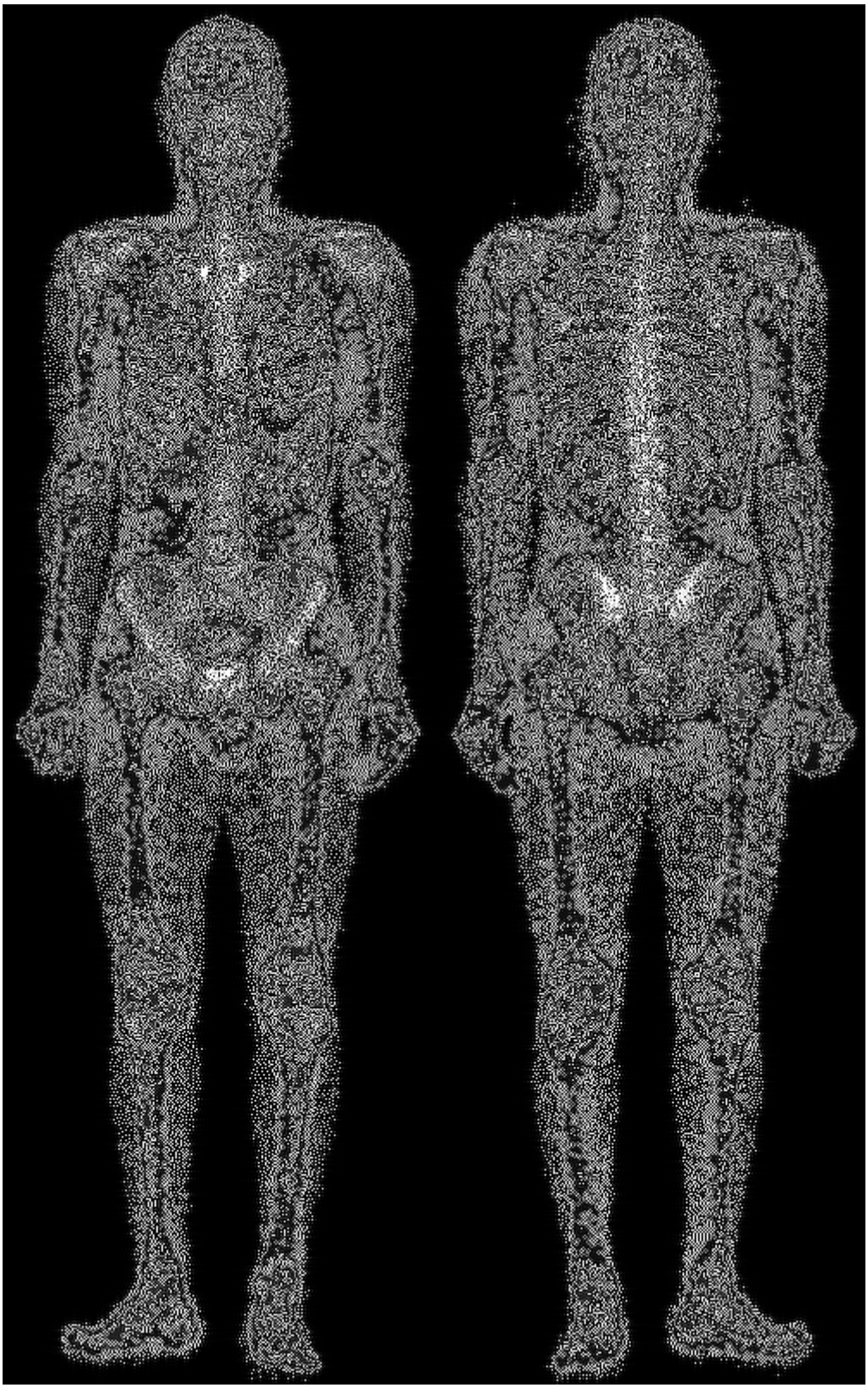
skeleton

blurry_moon

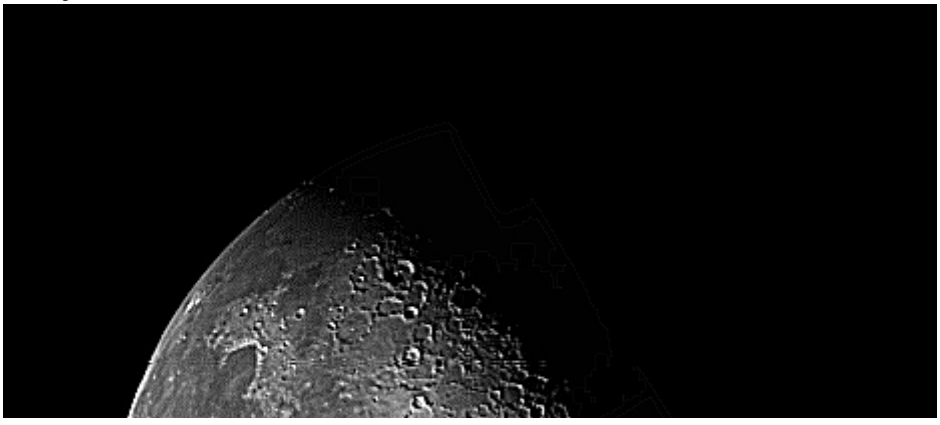


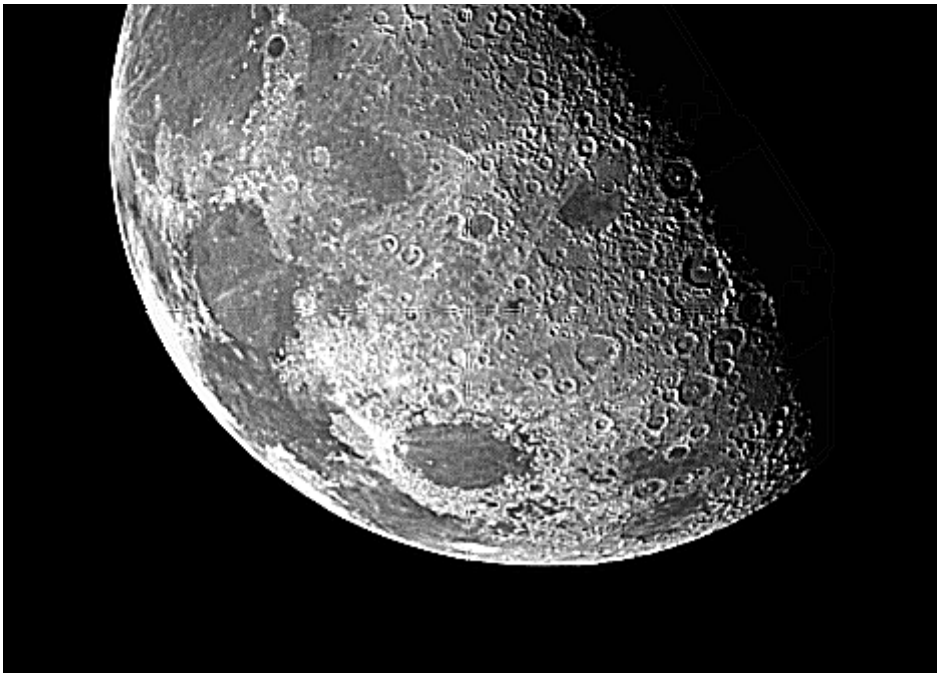
LaplacianFrequency

skeleton



blurry_moon

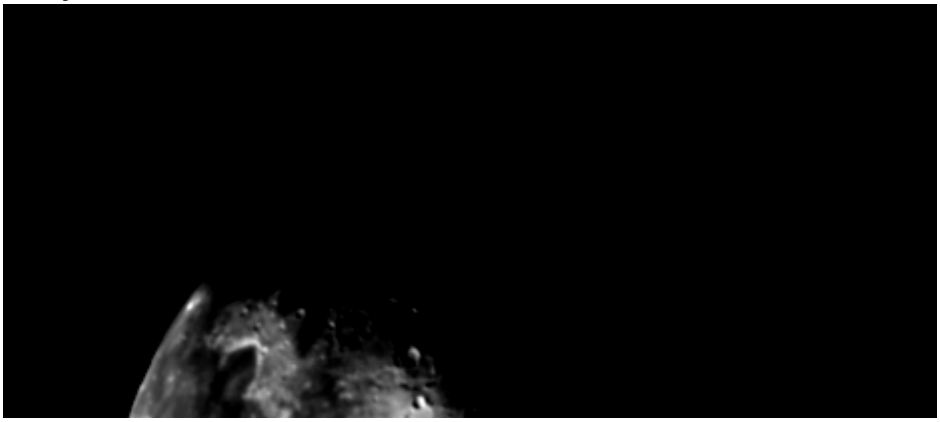




UnsharpMaskingSpatial

skeleton

blurry_moon



UnsharpMaskingFrequency

skeleton

blurry_moon

3 Discussions

HighBoost再Spatial上骷顱頭的圖顯得有點多雜訊，可能是本身圖噪點就很多了，所以更加被放大了，月亮感覺有點過曝的感覺，相較之下Frequency domain下就相對好很多，不但骨骼有變明顯外，月亮和骷髏的細節也被保存下來。

Laplacian就和HighBoost相反在Spatial domain上表現比Frequency domain好很多，Spatial domain上處理噪點被放大的很多，反而導致輪廓沒那麼清楚。

UnsharpMasking部分使用原圖減去經high pass filter(Frequency domain)處理的效果比但純的平均還要好很多。

4 References and Appendix

powerpoint on ecourse2
https://www.mathworks.com/matlabcentral/fileexchange/88602-frequency-domain-highpass-filtering-on-images-2-d-domain?s_tid=srchtitle
https://www.mathworks.com/matlabcentral/fileexchange/53250-filtering-of-an-image-in-frequency-domain