Image Processing Homework 1

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1 Technical description

Enhance the three given images by three spatial image enhancement techniques: (1) power-law (gamma) transformation, (2) histogram equalization, (3) image sharpening using the Laplacian operator.

1.1 power-law (gamma) transformation

First, import the images and transform to gray level bitmap format, then using the basic form power-law transformations:

$$s = cr^{\gamma}$$

then print all image using subplot and imshow.

```
clc;clear all;close all;

c = 1;
images = ["Jetplane.bmp","Lake.bmp","Peppers.bmp"];
gammas = [0.1, 0.4, 1, 2.5, 10];

for i = 1 : length(images)
    for j = 1 : length(gammas)
        subplot(3,5,(i-1)*length(gammas)+j);
        imshow(powerLaw(images(i),1,gammas(j)));
        title(images(i) + ' gamma ' + gammas(j) );
    end
end

function Image = powerLaw(filename,c,gamma)
    % transform image to gray level bitmap
    [indexedImage, customColorMap] = imread(filename);
    Image = ind2rgb(indexedImage, customColorMap);
    Image = rgb2gray(Image);
    [x,y] = size(Image);
    % As shown in Fig. 3.6
    % power-law transformations have the basic form:
    % where c and gamma are positive constants.
    % s = c * ( r ^ gamma)
    for i = 1 : x
        for j = 1 : y
            Image(i, j) = c * (Image(i, j)^ gamma);
        end
    end
end
```

1.2 histogram equalization

First, import the images and transform to gray level bitmap format. Second, caculate the pdf and cdf of the images. Third, then get inverse transformation from s back to r. Finally, print all image using subplot and imshow.

```
clc;clear all;close all;

images = ["Jetplane.bmp","Lake.bmp","Peppers.bmp"];

for i = 1 : length(images)
        [OriginalImage, ProcessedImage] = histogramEq(images(i))
        subplot(length(images),4,4 * (i - 1) + 1);
        imshow(OriginalImage);
        title(images(i));
        subplot(length(images),4,4 * (i - 1) + 2);
        histogram(OriginalImage,256,BinLimits=[0,255]);
        title(images(i) + ' Histogram');
        % processed image
        subplot(length(images),4,4 * (i - 1) + 3);
        imshow(ProcessedImage);
        title(images(i) + ' Processed');

        subplot(length(images),4,4 * (i - 1) + 4);
        histogram(ProcessedImage,256,BinLimits=[0,255]);
        title(images(i)+ ' Processed Histogram');
end

function [ImageIntOrigin, ImageFinal] = histogramEq(filename)
 % transform image to gray level bitmap
    [indexedImage, customColorMap] = imread(filename);
    Image = ind2rgb(indexedImage, customColorMap);
    Image = rgb2gray(Image);
    [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
            ImageIntOrigin(i, j) = uint8(Image(i, j) * 255);
            ImageInt(i, j) = uint8(Image(i, j) * 255) + 1;
        end
    end
 % count all value
    ImageCount = zeros(1,256)
    for i = 1 : x
        for j = 1 : y
            ImageCount((ImageInt(i, j))) = ...
            ImageCount((ImageInt(i, j))) + 1;
        end
    end
 % caculate pdf( probability density function ) of image
    for i = 1 : 256
            ImagePdf(i) = double(ImageCount(i)) / (n * 1.0);
    end
 % caculate cdf( cumulative distribution function ) of image
    ImageCdf = ImagePdf;
    for i = 2 : 256
            ImageCdf(i) = ImageCdf(i - 1) + ImagePdf(i);
```

```
    end
 % cnf * 255(max)
    for i = 1 : 256
            ImageMap(i) = uint8(ImageCdf(i) * 255);
    end
 % mapping to new picture
    for i = 1 : x
        for j = 1 : y
            ImageFinal(i, j) = ImageMap(ImageInt(i, j));
        end
    end
end
```

1.3 image sharpening using the Laplacian operator

First, import the images and transform to gray level bitmap format, then using this filter:

$$\begin{matrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{matrix}$$

-4 less then 0, so

$$g\left(x,y\right) = f\left(x,y\right) - \nabla^2 f\left(x,y\right)$$

then print all image using subplot and imshow.

```
clc;clear all;close all;

images = ["Jetplane.bmp","Lake.bmp","Peppers.bmp"];

for i = 1 : length(images)
        [OriginalImage, ProcessedImage] = sharpening(images(i));
        subplot(length(images),2,2 * (i - 1) + 1);
        imshow(OriginalImage);
        title(images(i));
        % processed image
        subplot(length(images),2,2 * (i - 1) + 2);
        imshow(ProcessedImage);
        title(images(i) + ' Processed');
end


function [ImageInt, ImageProcessed] = sharpening(filename)
  % transform image to gray level bitmap
    [indexedImage, customColorMap] = imread(filename);
    Image = ind2rgb(indexedImage, customColorMap);
    Image = rgb2gray(Image);
    [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) * 255);
        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
```

2 Experimental results

2.1 power-law (gamma) transformation

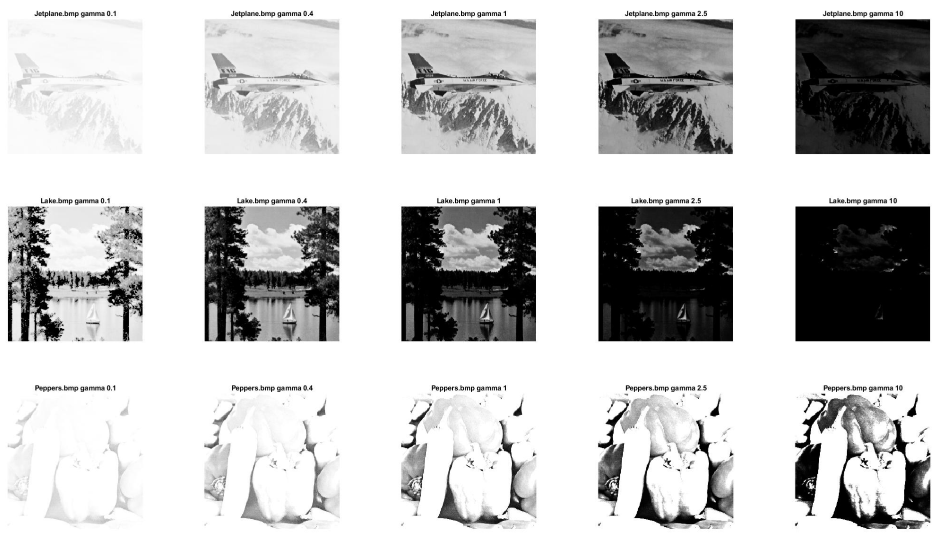

Figure 1: power-law transformation

2.2 histogram equalization

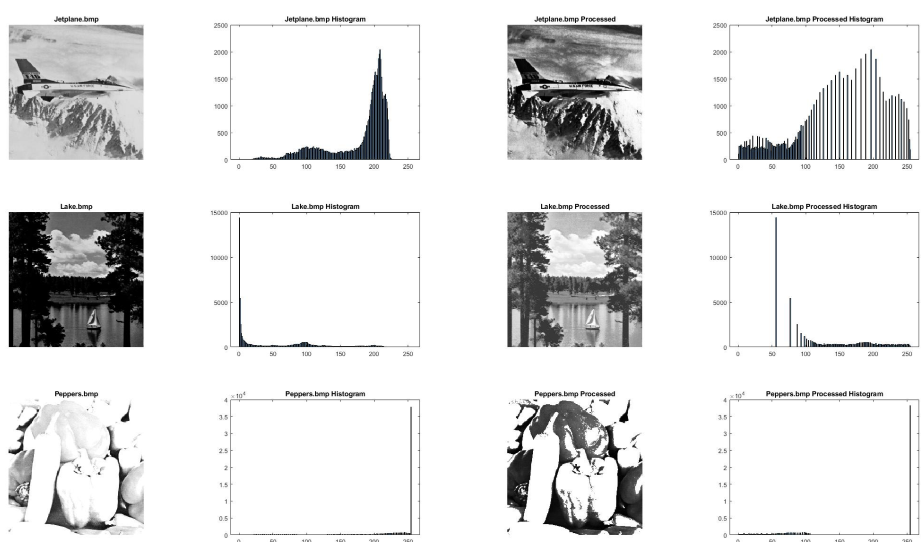

Figure 2: histogram equalization

2.3 image sharpening using the Laplacian operator

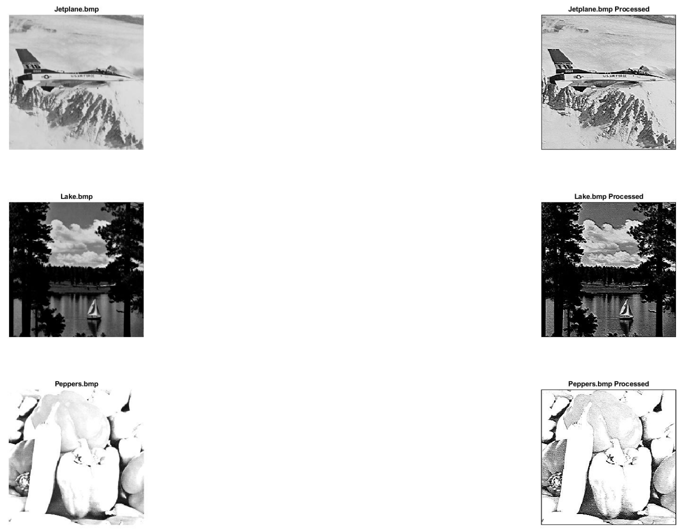

Figure 3: image sharpening using the Laplacian operator

3 Discussions

The image is darker when we have greater gamma value, then it is brighter when we have less smaller gamma value. After histogram equalization, We can get the better view of the image after the process, but it also have unrealistic effects in images. Image sharpening using the Laplacian operator is great at the plane image, it make the word on the plane more clear to recognize. In the lake image, the boundary of the leaves is more clear . But the pepper image, the pepper look more rough then the image unprocessed.

4 References and Appendix

powerpoint on ecourse2