ECES 435
Professor Matthew Stamm
Assignment 5
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Part 1: Detecting Image Contrast Enhancement

Based off your knowledge of contrast enhancement fingerprints, which of these images are likely to have been contrast enhanced?

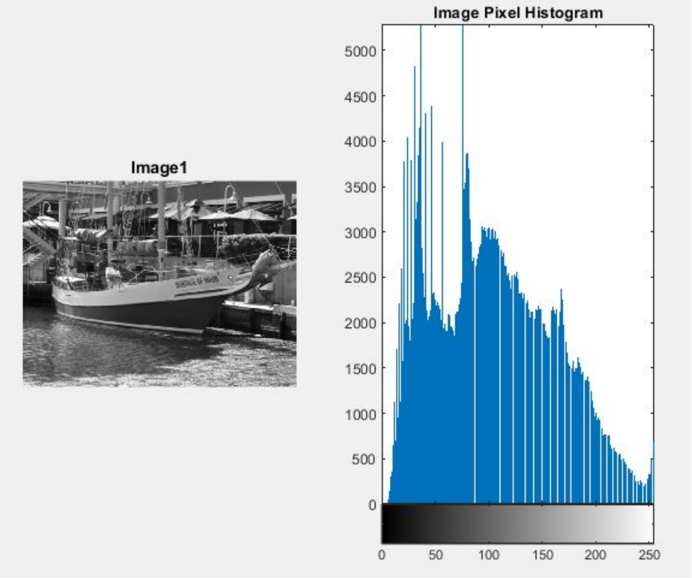
After performing contrast enhancement on an image, certain fingerprints are left behind. To determine if an image has previously experienced contrast enhancement, the pixel value histogram is inspected. Normally, the pixel value histogram of an unaltered digital image will appear smooth. In an altered image, the fingerprints appear as impulsive peaks and gaps in its pixel value histogram. After inspecting the PVH of the 4 images below, the following results were determined:

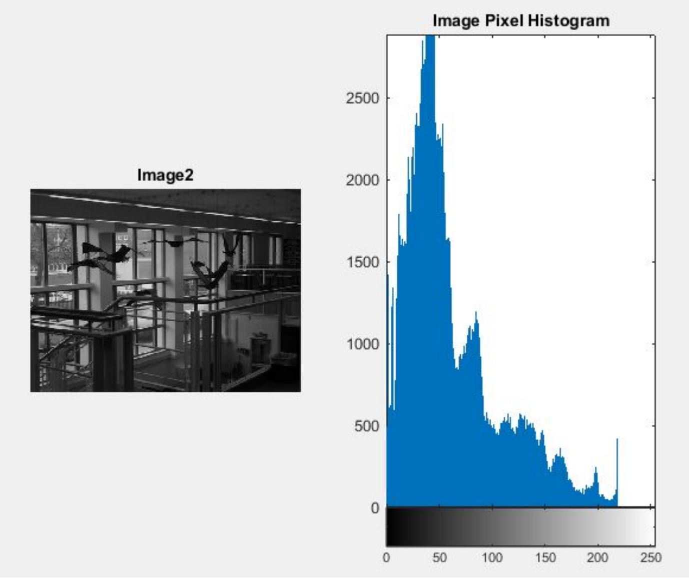
Image 1: Likely contrast enhanced, has sharp peaks in the left half of the histogram and gaps in the right half.

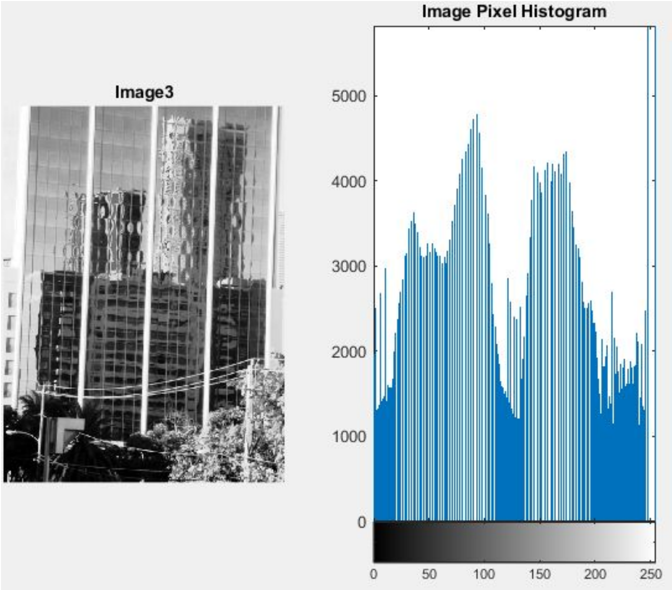
Image 2: Likely not contrast enhanced, PVH is generally smooth but possibly altered because the PVH is no values past 220.

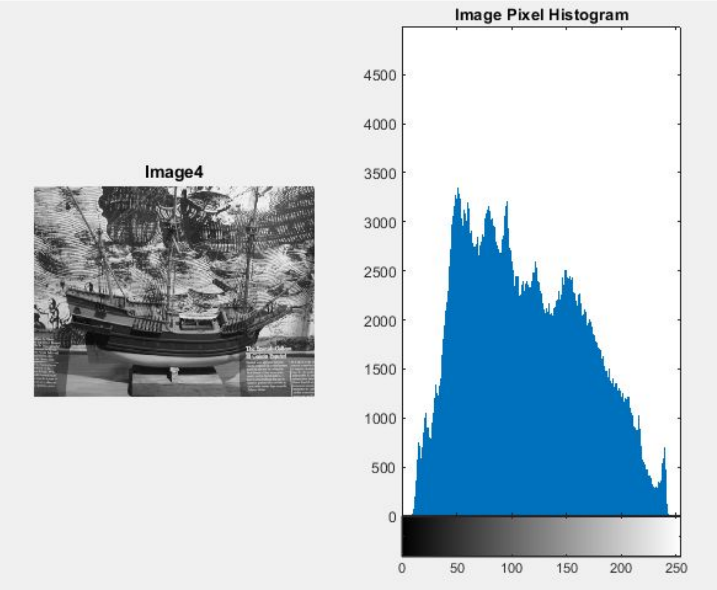
Image 3: Unsure but likely contrast enhanced, even though there are some gaps and peaks, the PVH is generally smooth. The weird PVH is likely due to the image content - the middle parts of the building are very very bright, leading to a high right side peak.

Image 4: Likely not contrast enhanced, the PVH is very smooth with no fingerprints.





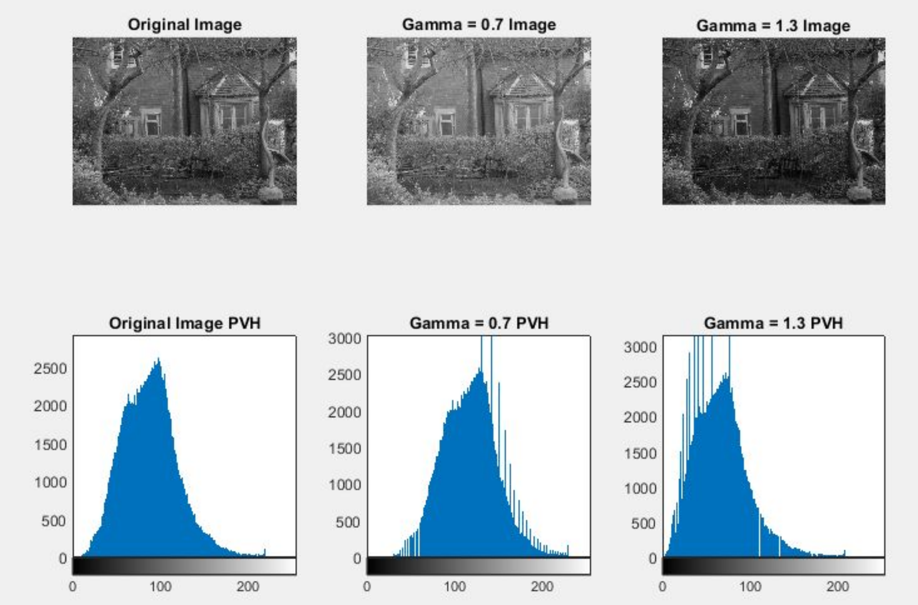


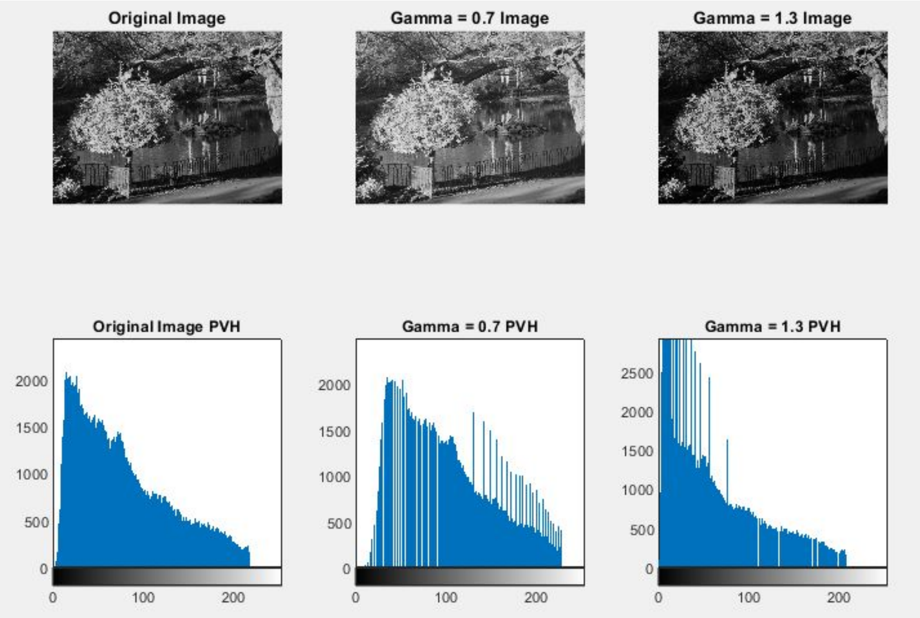


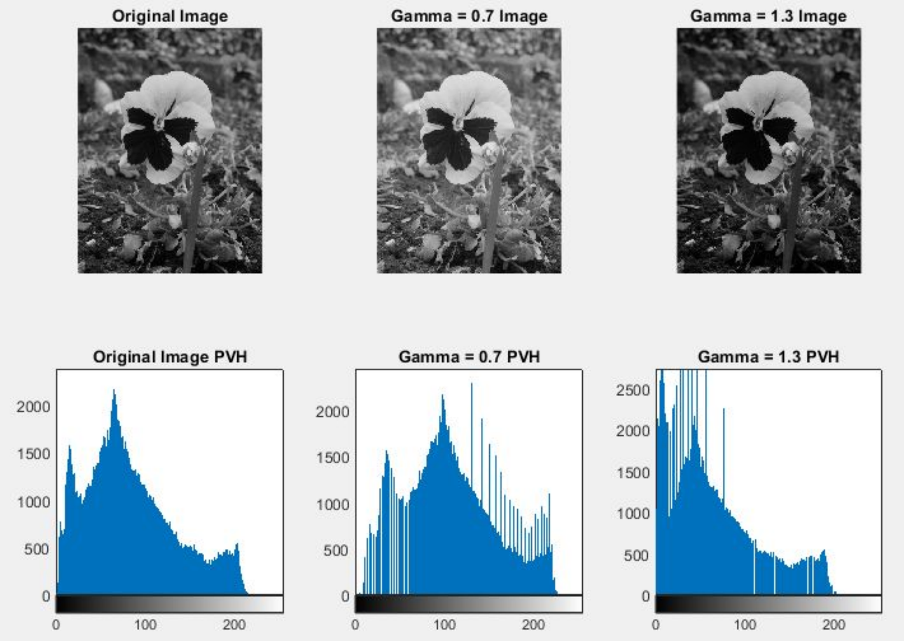
What influence does the unaltered image's pixel value histogram have on the location and amplitude of the contrast enhancement fingerprints in each of the gamma corrected images? What influence does the contrast enhancement mapping (in this case specified by the value of gamma) have on the location and amplitude of the contrast enhancement fingerprints in each of the gamma corrected images?

The unaltered image’s PVH keeps its shape after gamma correction, but either shifted left or right depending on gamma. After gamma correction, gaps appear on one side of the PVH and peaks appear on the opposite side, centered around the average of the PVH. These fingerprints changed location depending on the contrast enhancement mapping, or the gamma value.

When gamma is less than 1, gaps appear on the left (0) side, and peaks appear on the right (255) side. Since values are taken from the dark side and added to the light side, the image appears lighter. The opposite is true when gamma is greater than 1, gaps appear on the right (255) side, and peaks appear on the left (0) side. Since values are taken from the light side and added to the dark side, the image appears darker.

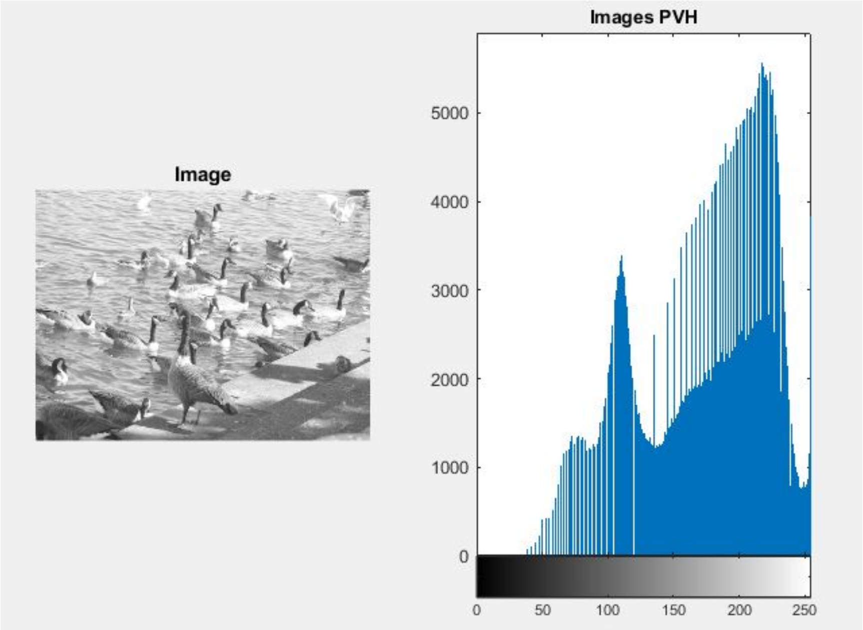

Original Image
Gamma = 0.7 Image
Gamma = 1.3 Image
Original Image PVH
2500
2000
1500
1000
500
0
0
100
200
Gamma = 0.7 PVH
3000
2500
2000
1500
1000
500
0
0
100
200
Gamma = 1.3 PVH
3000
2500
2000
1500
1000
500
0
0
100
200


Original Image
Gamma = 0.7 Image
Gamma = 1.3 Image
Original Image PVH
2000
1500
1000
500
0
0
100
200
Gamma = 0.7 PVH
2000
1500
1000
500
0
0
100
200
Gamma = 1.3 PVH
2500
2000
1500
1000
500
0
0
100
200



Examine its pixel value histogram and identify which regions of the contrast enhancement mapping are locally expansive and which are locally contractive. Based on this information, is gamma greater than 1 or less than 1?

As discovered in the previous question, gamma correction fingerprints appear in the PVH as gaps and peaks, separated around the average of the PVH. In this image, the PVH has gaps in the left (0, dark) side, and has peaks in the right (255, light) side. This means the regions of gamma correction that are locally expansive are the right side, and locally contractive are the left side. By expanding the light values and contracting the dark values, the entire image appears lighter. This effect is consistent with gamma correction where gamma is less than 1.



Part 2: Detecting Image Resampling and Resizing

Which of these p-maps exhibit periodic properties that are indicative of image resampling?

After performing resampling operations, very obvious artifacts are left in the image's p-map. Periodic patterns are left throughout the p-map that often look like a grid. From inspecting the p-maps of the 4 images below (second row), the following results were determined:

Image 1: Likely not resampled, p-map only has noise, no periodic resampling artifacts

Image 2: Likely resampled, p-map only shows clear periodic resampling artifacts

Image 3: Likely resampled, p-map only shows very obvious periodic resampling artifacts

Image 4: Likely not resampled, p-map only has noise, no periodic resampling artifacts

Which of these plots contain resampling fingerprints? Include the plot of the magnitude of the Fourier transform of each image's p-map in your report. If contrast enhancement fingerprints are present in an image, clearly label these fingerprints.

Resampling fingerprints become most evident after transforming into the frequency domain using the discrete fourier transform. In the frequency domain, the artifacts lead to characteristic peaks in the spectrum that appear as 4 adjacent dots.
From inspecting the frequency p-maps of the 4 images below (third row), the following results were determined:

Image 1: No fingerprints in magnitude of DFT, likely not resampled

Image 2: Clear fingerprints in magnitude of DFT, likely resampled

Image 3: Clear fingerprints in magnitude of DFT, likely resampled

Image 4: Unsure, no clear fingerprints, but weird noise that could resemble the artifacts of resampling in magnitude of DFT

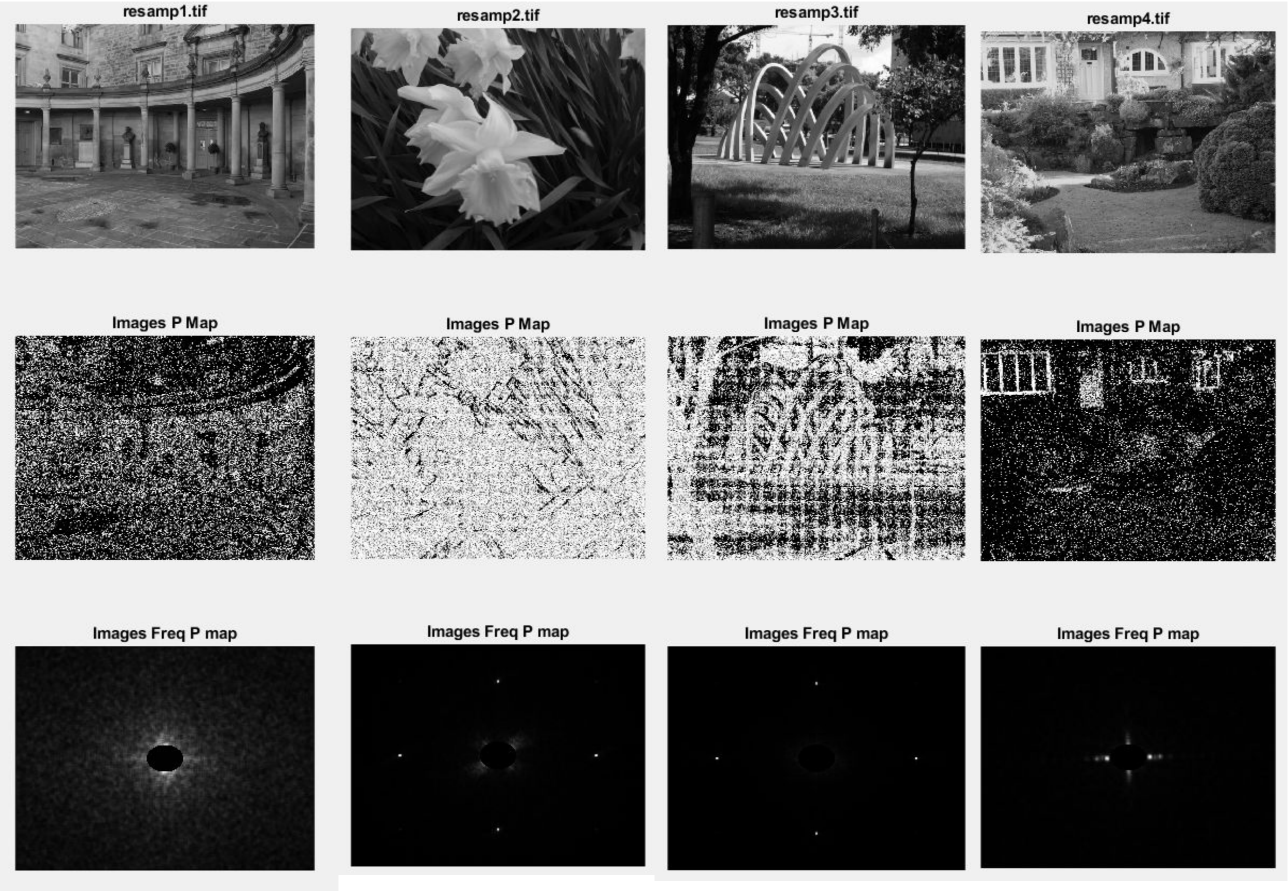


Table of Contents

```
%ECES435 Assignment 5 - By Wanyu Li and John Seitz
close all; clear all; clc;
%Note: Code works best if you run each section independently!
```

Part 1 - 1st Task - Contrast Enhancement

```
Imgs = {'imageCE1.tif','imageCE2.tif','imageCE3.tif','imageCE4.tif'};
%Load in images


for i = 1:length(Imgs) % Loop for all 4 images
    newimg = imread(Imgs{i});
    figure(i);
    subplot(1,2,1);
    imshow(newimg);
    title(['Image',sprintf('%d',i)]);
    subplot(1,2,2);
    imhist(newimg); % use imhist to calculate the image's PVH
    title('Image Pixel Histogram');
end
```

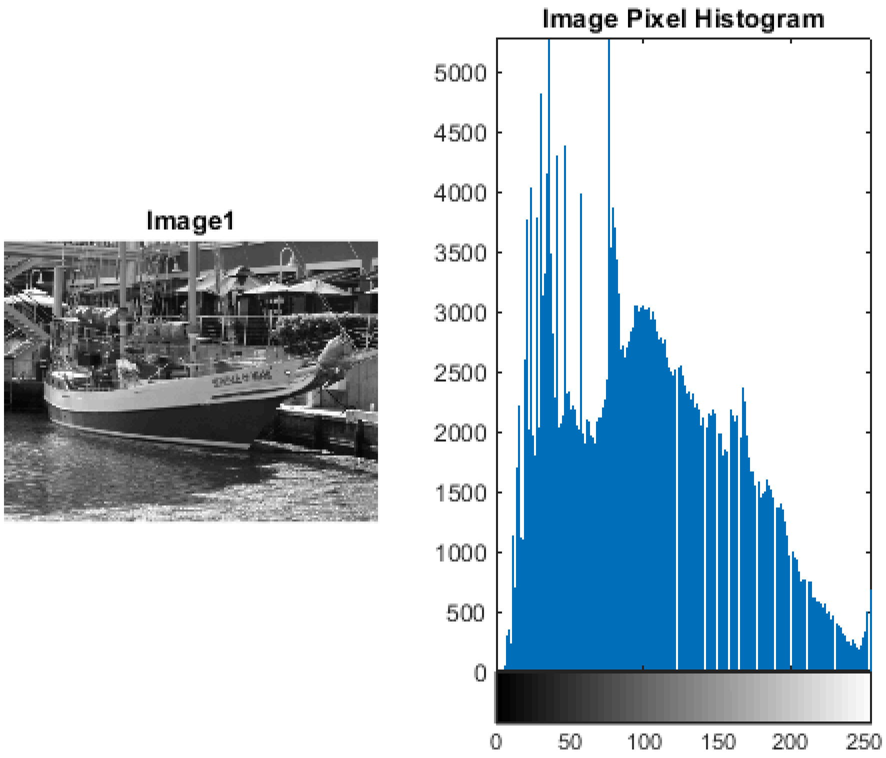


Image1
Image Pixel Histogram
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250

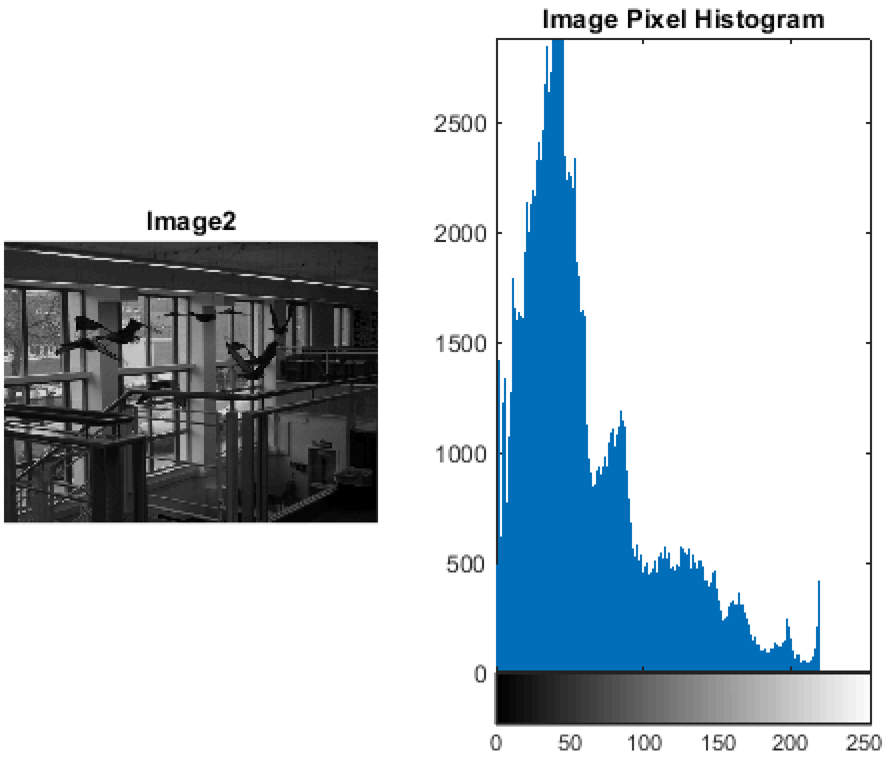


Image2
Image Pixel Histogram
2500
2000
1500
1000
500
0
0
50
100
150
200
250

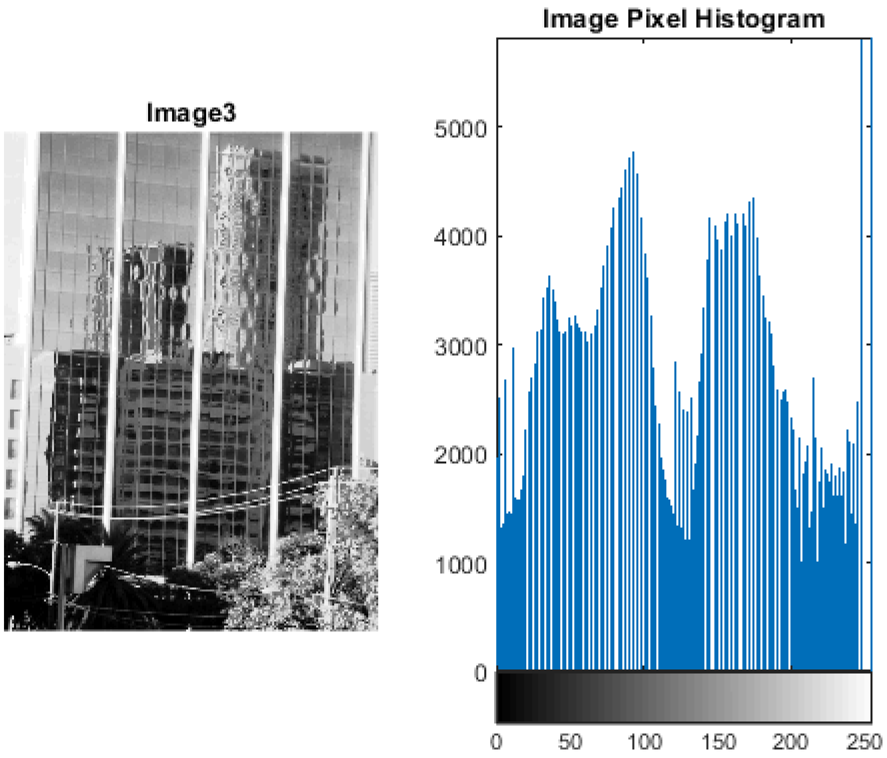


Image3
Image Pixel Histogram
5000
4000
3000
2000
1000
0
0
50
100
150
200
250

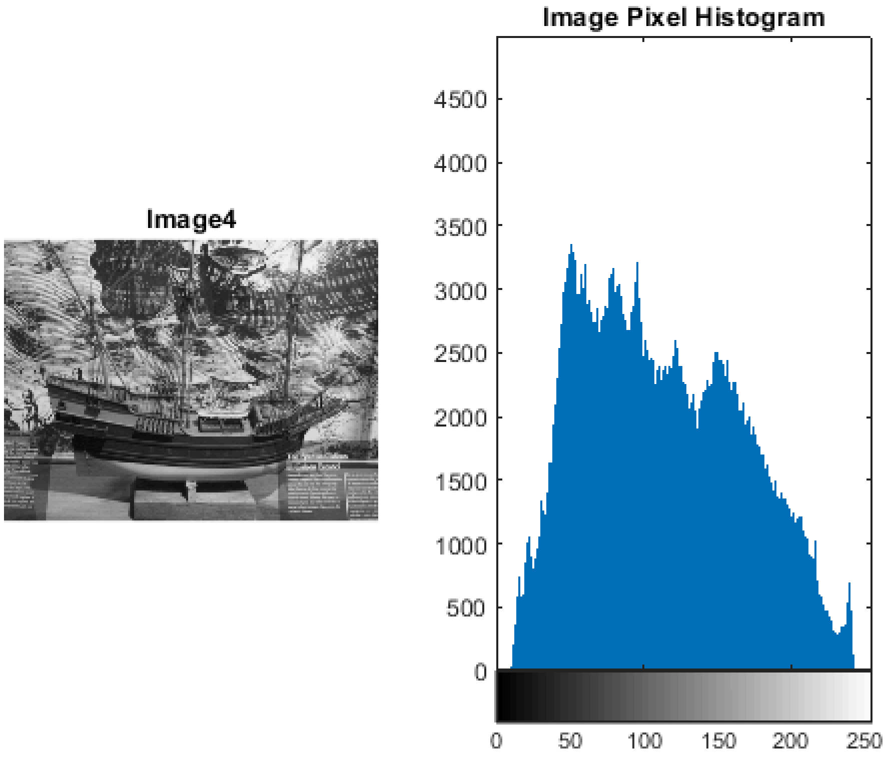
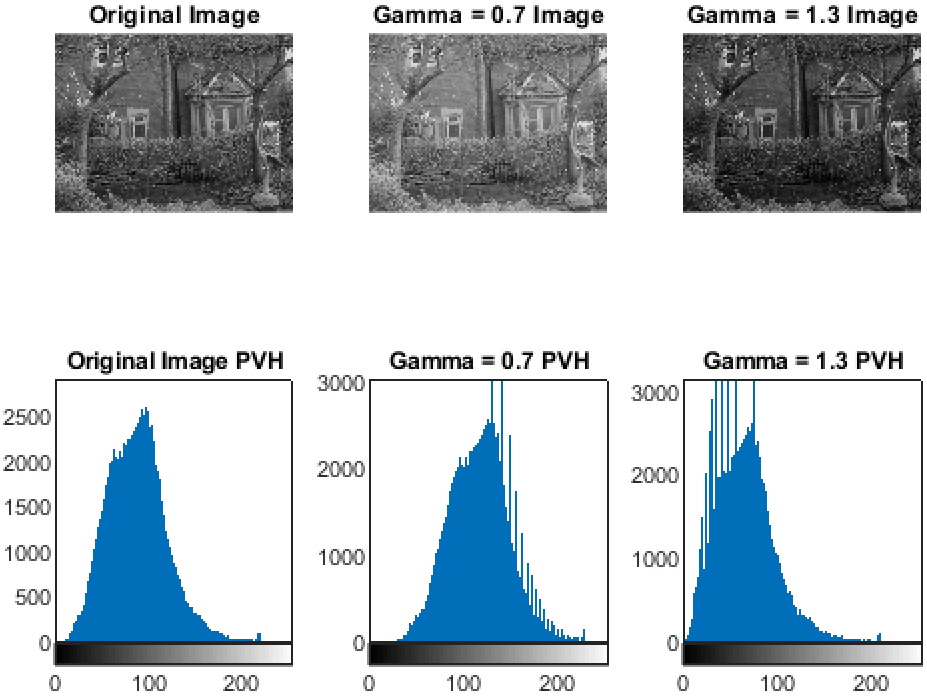
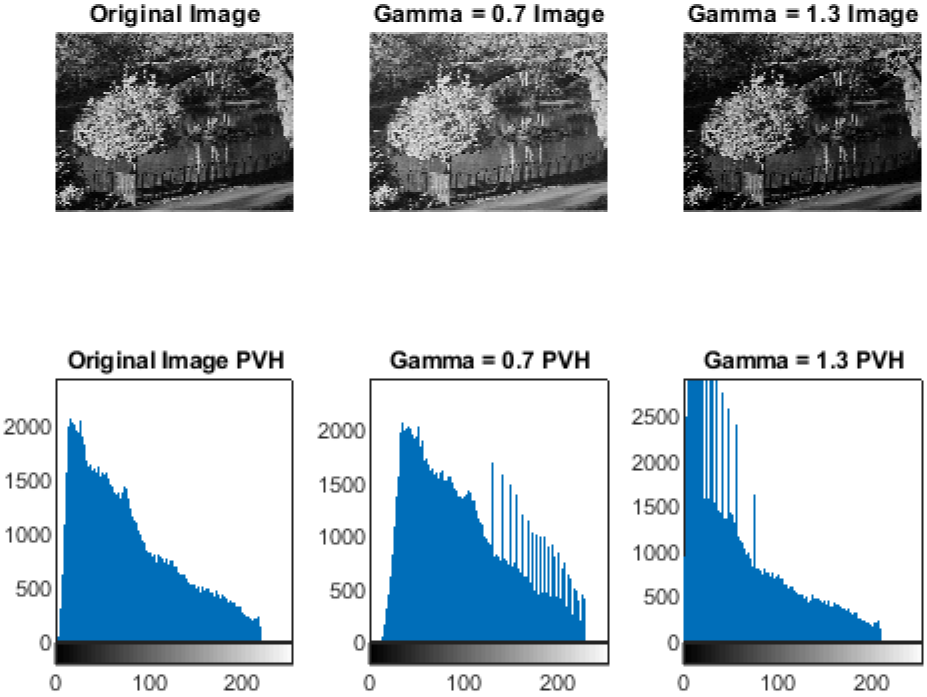


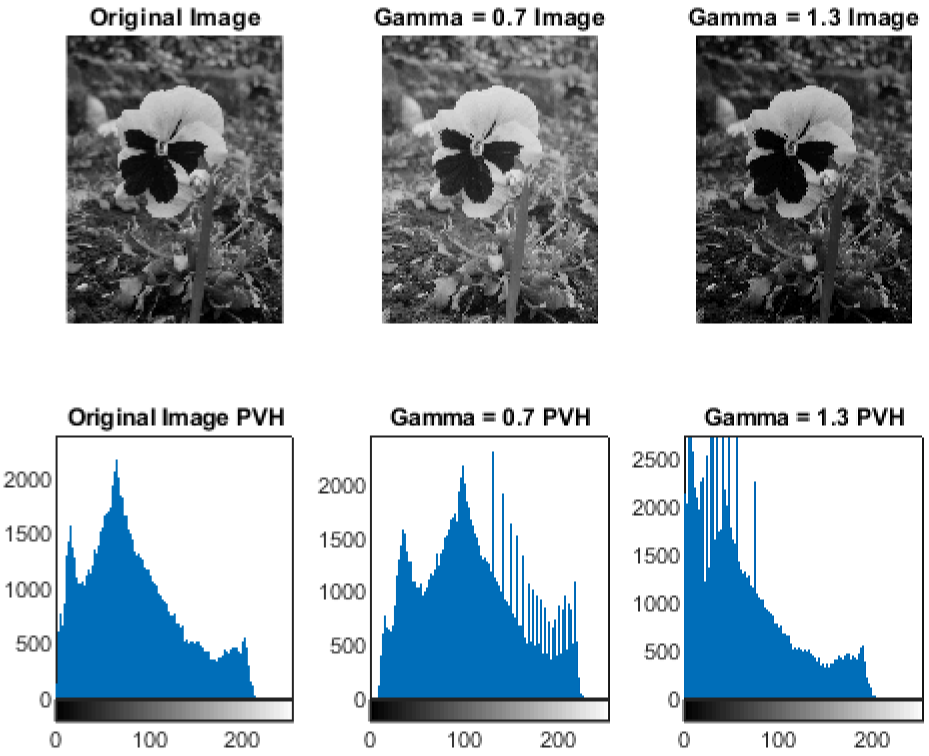
Image4
Image Pixel Histogram
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250

Part 1 - 2nd Task - Gamma Correction

```
P12Imgs = {'unaltIm1.tif','unaltIm2.tif','unaltIm3.tif'};

for k = 1:length(P12Imgs)

    img = imread(P12Imgs{k});
    figure(k);
    subplot(2,3,1);
    imshow(img);
    title('Original Image')

    subplot(2,3,2);
    newimg = gammacorrect(0.7,img);
    newimg = uint8(newimg);
    imshow(newimg)
    title 'Gamma = 0.7 Image'

    subplot(2,3,3);
    newimg = gammacorrect(1.3,img);
    newimg = uint8(newimg);
    imshow(newimg)
    title 'Gamma = 1.3 Image'

    img = imread(P12Imgs{k});
    figure(k);
    subplot(2,3,4);
    imhist(img);
    title('Original Image PVH')

    subplot(2,3,5);
    newimg = gammacorrect(0.7,img);
    newimg = uint8(newimg);
    imhist(newimg)
    title 'Gamma = 0.7 PVH'

    subplot(2,3,6);
    newimg = gammacorrect(1.3,img);
    newimg = uint8(newimg);
    imhist(newimg)
    title 'Gamma = 1.3 PVH'

end
```

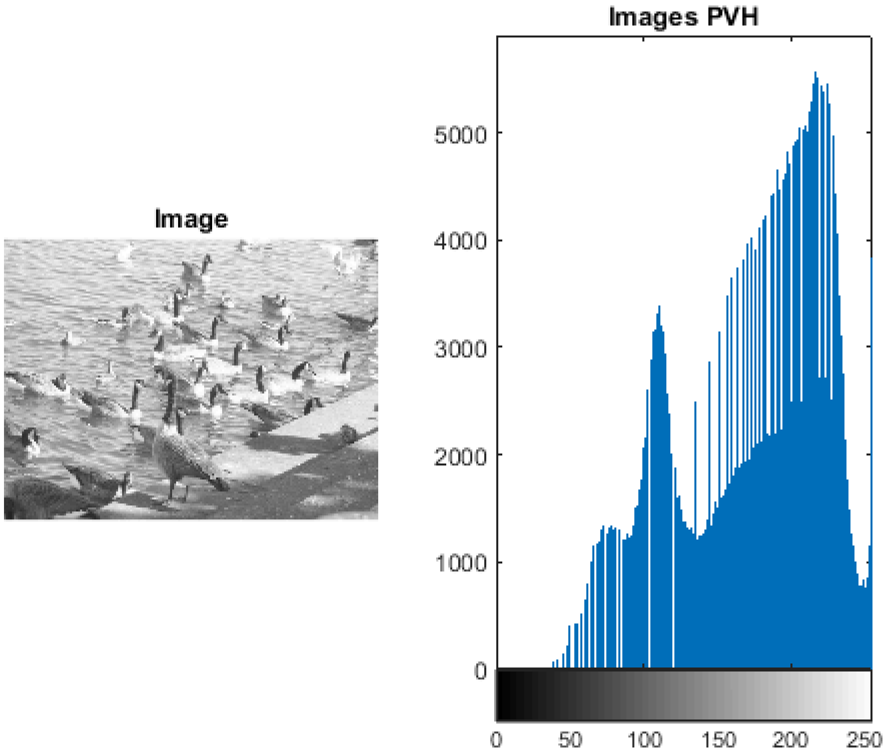

Original Image
Gamma = 0.7 Image
Gamma = 1.3 Image
Original Image PVH
2500
2000
1500
1000
500
0
0
100
200
Gamma = 0.7 PVH
3000
2000
1000
0
0
100
200
Gamma = 1.3 PVH
3000
2000
1000
0
0
100
200


Original Image
Gamma = 0.7 Image
Gamma = 1.3 Image
Original Image PVH
2000
1500
1000
500
0
0
100
200
Gamma = 0.7 PVH
2000
1500
1000
500
0
0
100
200
Gamma = 1.3 PVH
2500
2000
1500
1000
500
0
0
100
200



Part 1 - 3rd Task - Contractive or Expansive Mappings

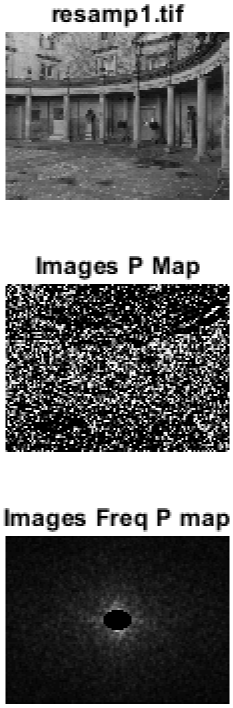
```
P3Img = imread('imageCE5.tif');

figure
subplot(1,2,1);
imshow(P3Img);
title('Image');

subplot(1,2,2);
imhist(P3Img);
title('Images PVH');
```



Part 2 - 1st Task - Detecting Image Resampling and Resizing

```
P2Imgs = {'resamp1.tif','resamp2.tif','resamp3.tif','resamp4.tif'};
%Load in images

l = 1; % Lamda value
t = 2; % Tau value
s = 1; % Sigma value
%Set values used in function below

for i = 1: length(P2Imgs)
    p_map = kirchnerPmap(P2Imgs{i},l,t,s); %Apply Kirchner P map
 function to obtain p map and frequency p map
end

%Following
type kirchnerPmap.m


function [p] = kirchnerPmap(Image,lamda,tau,sigma)
% This function was created to implement Kirchner's resampling
 detection
% algorithim using a fixed linear prediction filter to approximate
 this
```

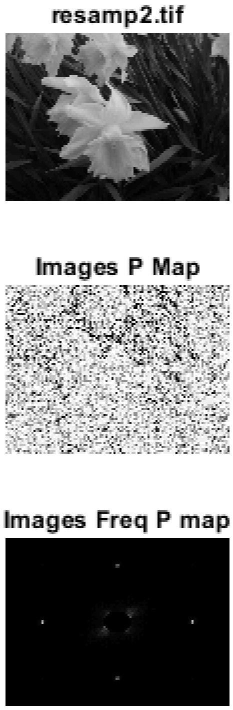
```
% relationship


img = double(imread(Image));
[x y] = size(img); % Get image dimensions

alpha_filter = [-0.25 0.5 -0.25
                  0.5 0 0.5
                -0.25 0.5 -0.25];

newimg = filter2(alpha_filter, img); % Apply the alpha filter
Error = img - newimg; % Calculate the error
p = lamda*exp(-Error.^tau/sigma); % Obtain the p-map

figure;
subplot(3,1,1);
imshow(uint8(img));%show the original img
title(string(Image));

subplot(3,1,2);
imagesc(p) % display the calculated p-map
title('Images P Map');

%The axis of plots must be normalized to allow for comparison, as done
%below

axis equal
axis off;
xlim([1 y]);
ylim([1 x]);

subplot(3,1,3);
showFreqPmap(p);
title('Images Freq P map');

axis equal
axis off;
xlim([1 y]);
ylim([1 x]);
end
```



resamp1.tif

Images P Map

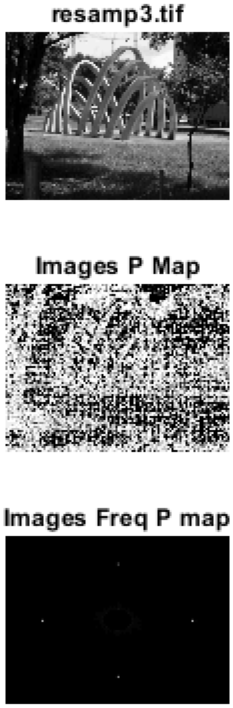
Images Freq P map

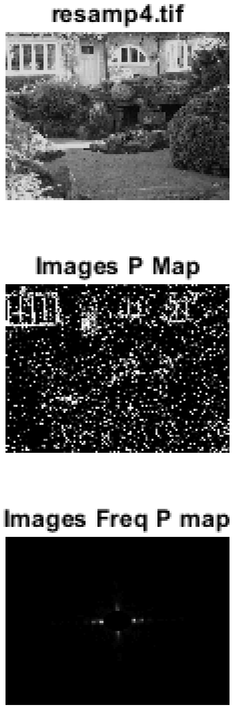


resamp2.tif

Images P Map

Images Freq P map


resamp3.tif
Images P Map
Images Freq P map


resamp4.tif
Images P Map
Images Freq P map

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