Lab 6: Contrast Enhancement and Resampling

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Image editing operations which are intended to only increase the perceptual quality of images, or not change the content, leave traces or fingerprints, which can be found by looking at statistics of the image. For example, contrast enhancement can be found by looking at pixel value histograms. Resampling can be detected using generic prediction error filters, and analysing the frequency of the estimated probability of errors.

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1 Detecting Image Contrast Enhancement

Contrast enhancement through gamma correction is a deterministic, non-linear mapping of pixel values. This non-linearity causes multiple pixel values to map to the same pixel value, and consecutive pixel values to be mapped further apart. Both of these phenomina are visible in the pixel value histograms of contrast enhanced images. The pixel value histograms of four images were viewed using MATLAB to determine if they were contrast enhanced or not. Next, several images were enhanced using gamma correction with gamma below and above 1, to view the effects that different gamma have on the histograms.

```
ce1=imread('Assignment6Files/imageCE1.tif');
ce2=imread('Assignment6Files/imageCE2.tif');
ce3=imread('Assignment6Files/imageCE3.tif');
ce4=imread('Assignment6Files/imageCE4.tif');
ce5=imread('Assignment6Files/imageCE5.tif');

subplot(1,2,1)
imhist(ce1)%ENHANCED
subplot(1,2,2)
imhist(ce2)
figure
subplot(1,2,1)
imhist(ce3)%ENHANCED
subplot(1,2,2)
imhist(ce4)

ui1=imread('Assignment6Files/unaltIm1.tif');
ui2=imread('Assignment6Files/unaltIm2.tif');
ui3=imread('Assignment6Files/unaltIm3.tif');

figure
subplot(3,1,1)
imhist(Gcorrection(ui1,.7))
subplot(3,1,2)
imhist(ui1)
subplot(3,1,3)
imhist(Gcorrection(ui1,1.3))

figure
subplot(3,1,1)
imhist(Gcorrection(ui2,.7))
subplot(3,1,2)
imhist(ui2)
subplot(3,1,3)
imhist(Gcorrection(ui2,1.3))

figure
subplot(3,1,1)
imhist(Gcorrection(ui3,.7))
subplot(3,1,2)
imhist(ui3)
subplot(3,1,3)
imhist(Gcorrection(ui3,1.3))

figure
imhist(ce5)

type('Gcorrection.m')
```

```
function [ img_out ] = Gcorrection(img_in, gama)
%Does gamma correction using the equation:
%    new=2558(old/255)^gamma
    img_out=uint8(255*(double(img_in)/255).^gama);
end
```

Given the histograms of images 1-4, we found the images 1 and 3 show contrast enhancement fingerprints, where images 2 and 4 have smoother histograms that do not appear to be altered. The sudden peaks and gaps in the histogram are characteristic of contrast enhanced images.

A number less than one raised to a power greater than one will result in a number even less than the original. Rounding will cause smaller numbers to be mapped together, while larger numbers will be mapped apart. Gamma correction with gamma greater than 1 will result in locally expansive regions in the area of the histogram representing light pixels. This will correspond to locally contractive regions in the area of the histogram representing dark pixel values. Gamma values less than 1 will cause the opposite behavior, locally expansive regions on the left of the histogram, and contractive regions on the right. Given this, it is likely that imageCE5.tif underwent gamma correction where gamma was less than 1.

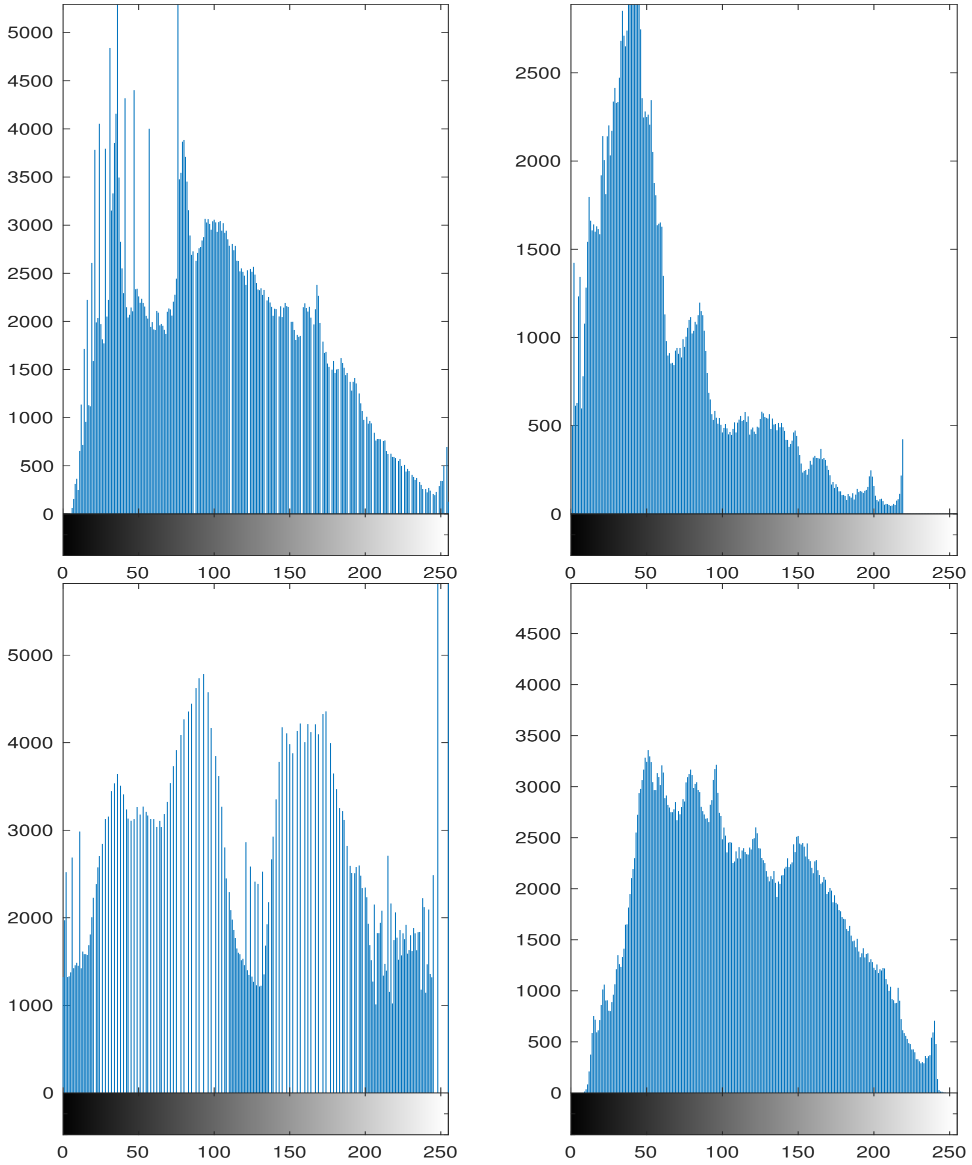


Figure 1: Pixel value histograms of imagesCE1.tif, imageCE2.tif, imageCE3.tif and imageCE4.tif

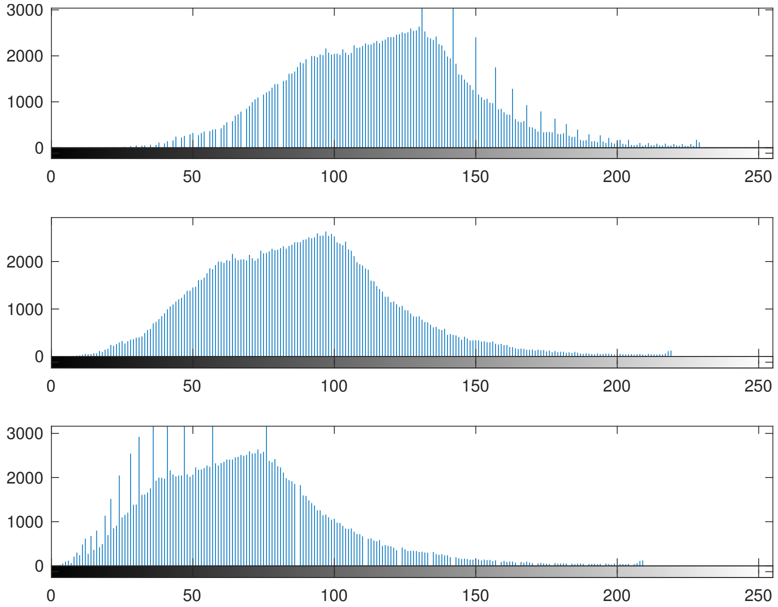


Figure 2: Pixel value histograms of unaltIm1.tif after gamma correction of 0.7, 1(no correction), and 1.3

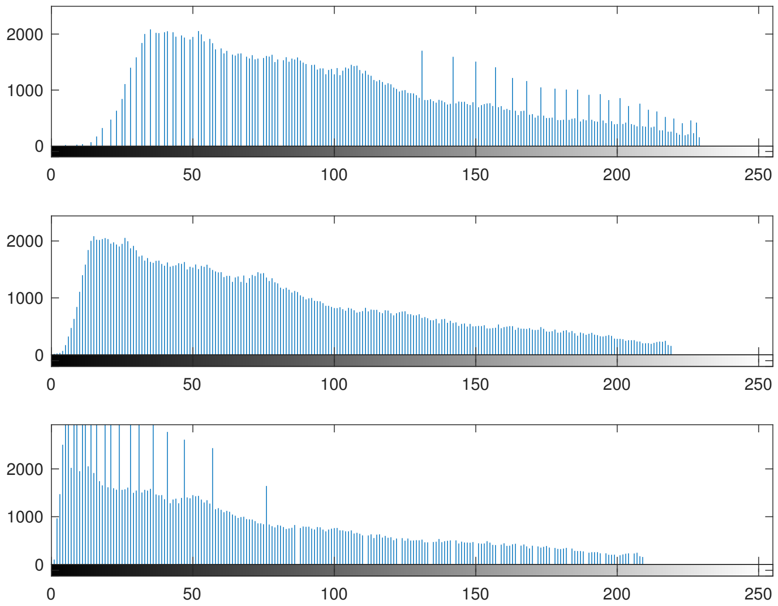


Figure 3: Pixel value histograms of unaltIm2.tif after gamma correction of 0.7, 1(no correction), and 1.3

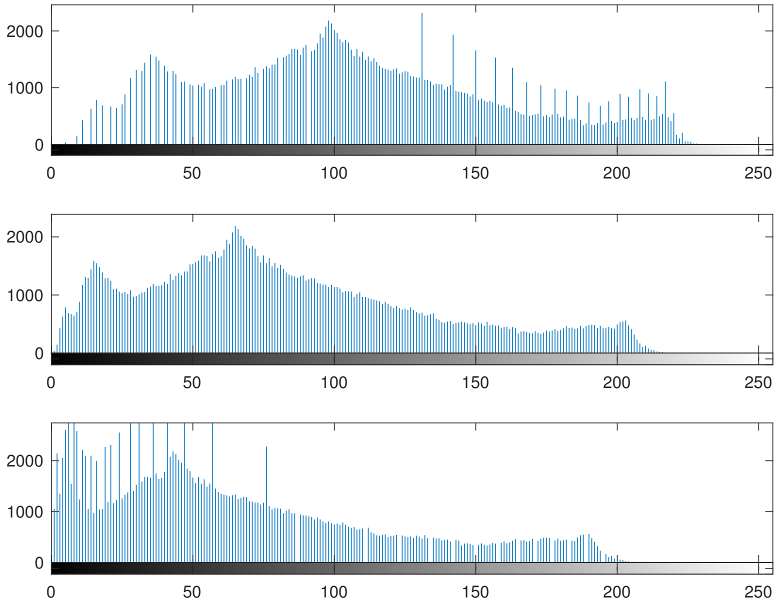


Figure 4: Pixel value histograms of unaltIm3.tif after gamma correction of 0.7, 1(no correction), and 1.3

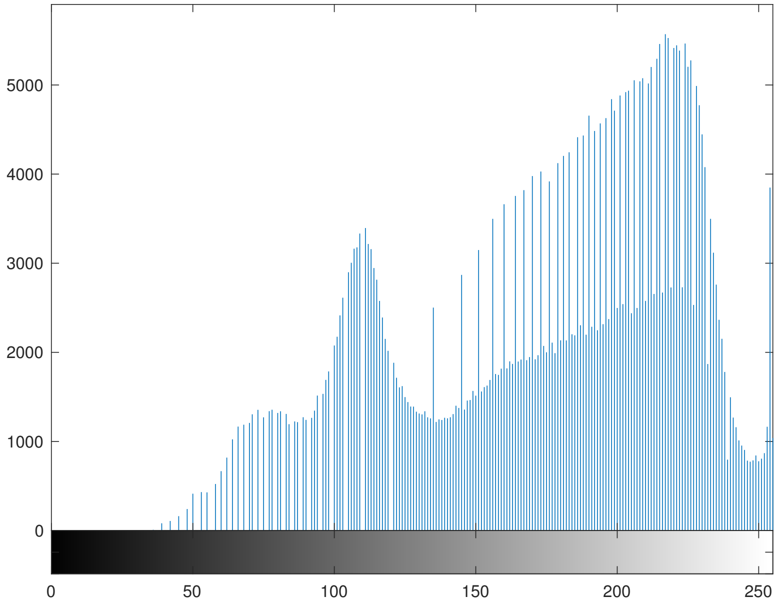


Figure 5: Pixel value histogram of imageCE5.tif showing gamma correction where gamma os less than 1

2 Detecting Image Resampling and Resizing

One of the most common image resampling operations is resizing. Image resampling fingerprints can be detected with the Popescu and Faird method but is computationally complex. The algorithm derived by Kirchner is an approximation of the same results but far less computationally intense. Kirchner's algorithm uses a fixed linear filter to approximate relationships between pixel values. The variance resulting from the predicted pixel error will be periodic. As seen in the below function Kirchner's algorithm, the image is first filtered with the linear prediction filter, then the error is calculated, and the p-map is then approximated with the below equation.

$$p(x,y) = \lambda exp^{\frac{-e(x,y)^{\tau}}{\sigma}} \tag{1}$$

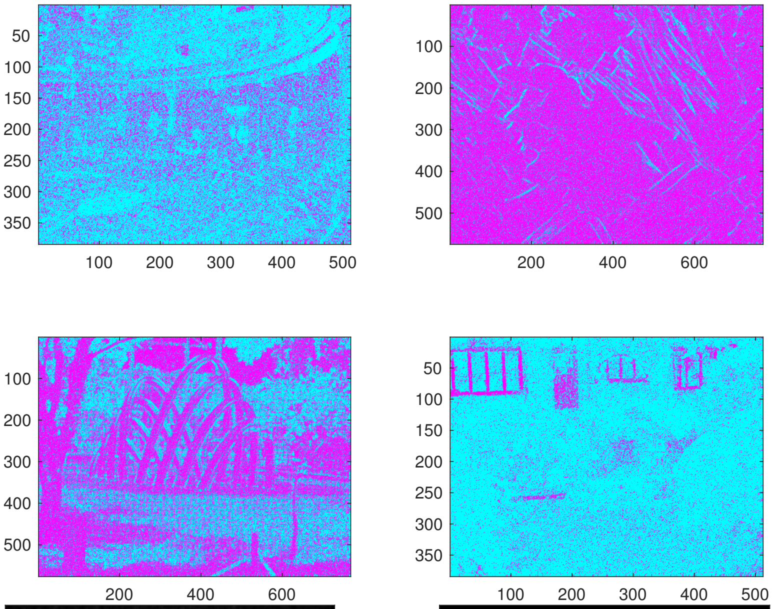
```
function [ pmap_approx ] = kirchners( im )
%KIRCHNERS approximates the pmap
%   Detailed explanation goes here
I=double(im);
% 1)
alpha=[-0.25 0.5 -0.25; 0.5 0 0.5;-0.25 0.5 -.25];
I_hat=filter2(alpha, I);
% 2)
pred_error=I-I_hat;
% 3)
lambda=1;
tau=2;
sigma=1;
pmap_approx=lambda*exp((-pred_error.^tau)./sigma);
end
\end{verbatim}

\begin{verbatim}
im1=imread('Assignment6Files/resamp1.tif');
im2=imread('Assignment6Files/resamp2.tif');
im3=imread('Assignment6Files/resamp3.tif');
im4=imread('Assignment6Files/resamp4.tif');
p1= kirchners( im1 );
p2= kirchners( im2 );
p3= kirchners( im3 );
p4= kirchners( im4 );

figure
subplot(2,2,1)
imagesc(p1)
colormap(cool)
subplot(2,2,2)
imagesc(p2)
subplot(2,2,3)
imagesc(p3)
subplot(2,2,4)
imagesc(p4)

figure
subplot(2,2,1)
showFreqPmap(p1)
subplot(2,2,2)
showFreqPmap(p2)
subplot(2,2,3)
showFreqPmap(p3)
subplot(2,2,4)
showFreqPmap(p4)
type('kirchners.m')
```

Below shows the p-map for the several images, the top-left and bottom-right images appear to have a periodic grid, so they are clearly resized. So just based off the p-maps resampIm2.tif and resampIm3.tif appear to be resized but the other two do not. But then the frequency of the p-map is calculated which showed that the not only 2 and 3 but also resampIm4.tif was resampled in at least one direction.


50
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