Digital Image Processing Laboratory 4

Pointwise Operations and Gamma
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February 14, 2020

100/100

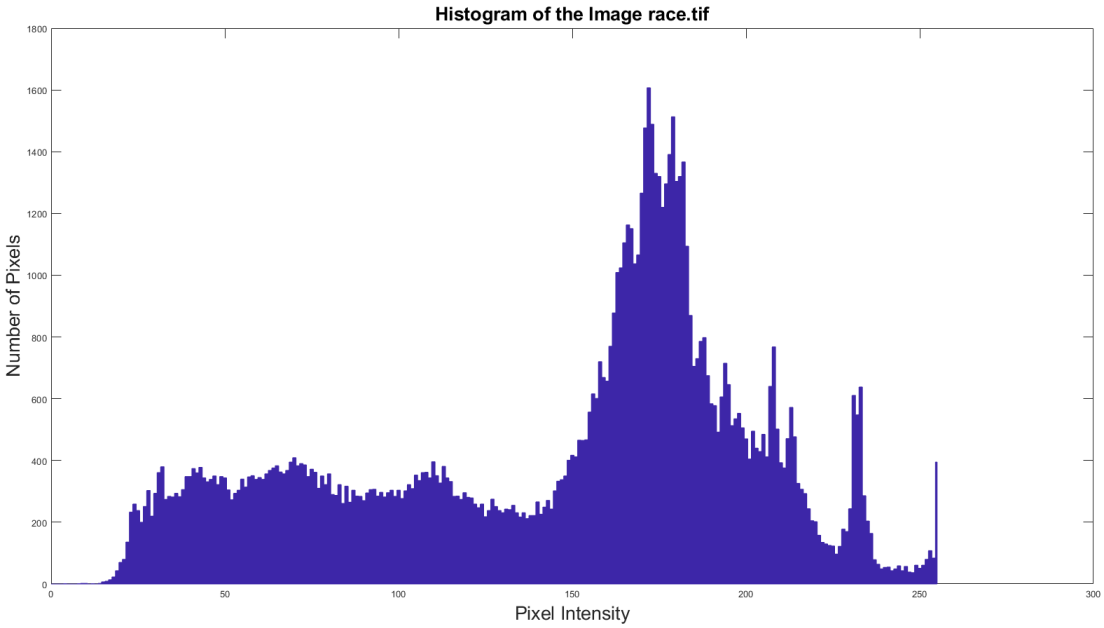
Note: The entire MATLAB code that uses the functions **equalize()**, **stretch()** and **checkerboard2()** has been attached at the end.

1 Histogram of an Image

The Histograms of the images are as shown below:

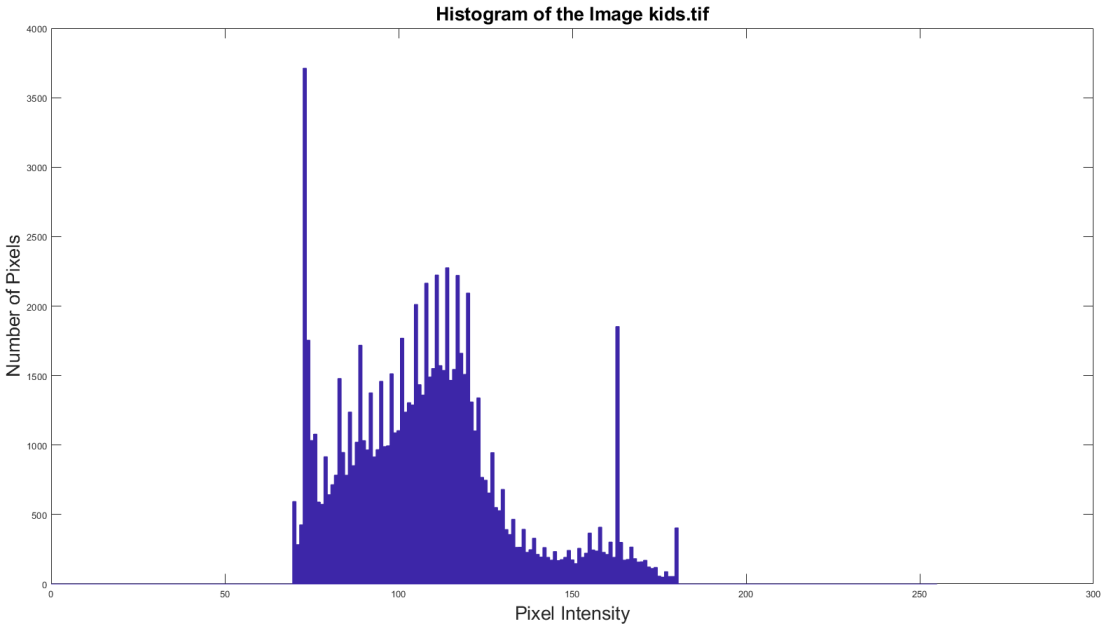
1.1 *race.tif* Original Image

1.2 *race.tif* Histogram



1.3 *kids.tif* Original Image

1.4 *kids.tif* Histogram



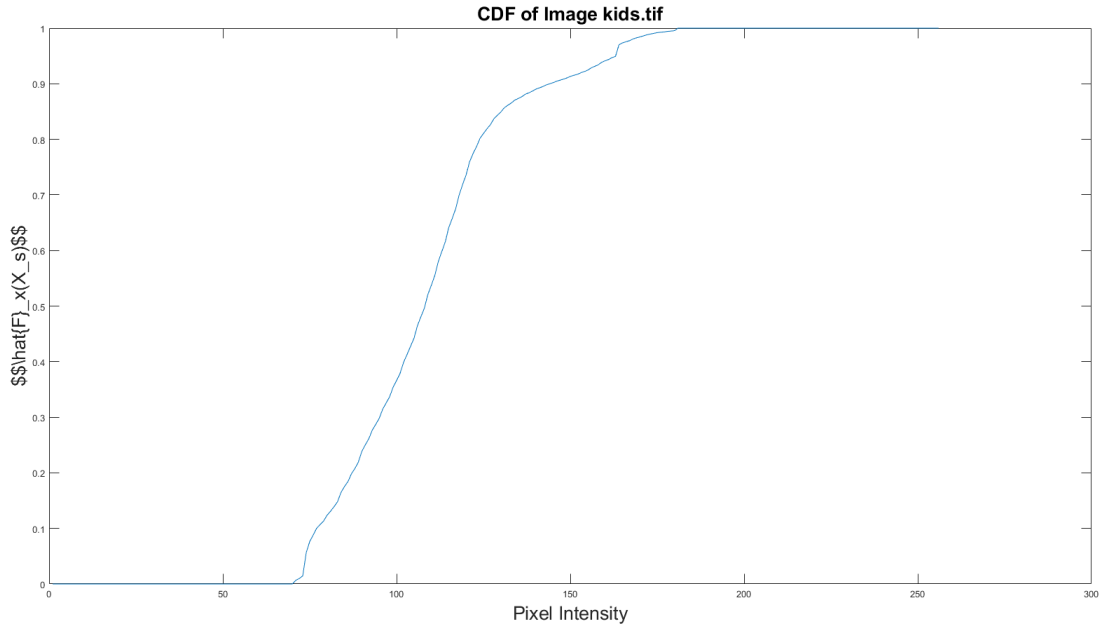
2 Histogram Equalization

In this section, we have equalized the histogram of the image, *kids.tif*

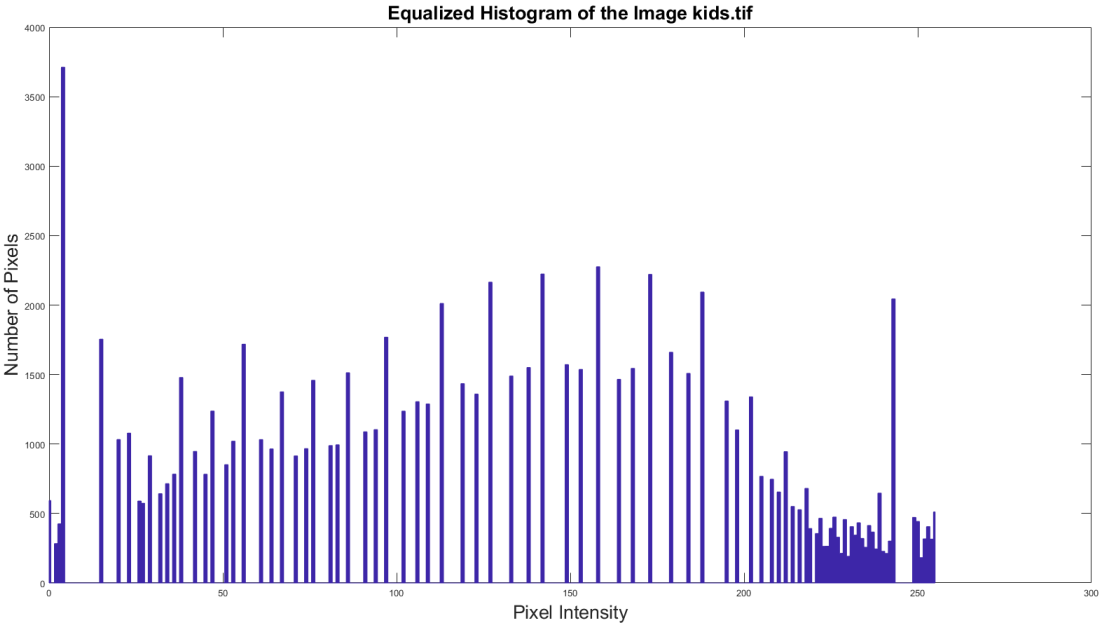
2.1 equalize.m

```
function [EqImg,CDF]=equalize(X)
    Xhist=hist(X(:),[0:255]);
    CDF=cumsum(Xhist)/sum(Xhist);
    minval=CDF(min(X(:)));
    maxval=CDF(max(X(:)));
    EqImg=uint8(255*((CDF(X)-minval)/(maxval-minval)));
end
```

2.2 CDF of the image



2.3 Histogram of the Equalized Image



2.4 Equalized Image

3 Contrast Stretching

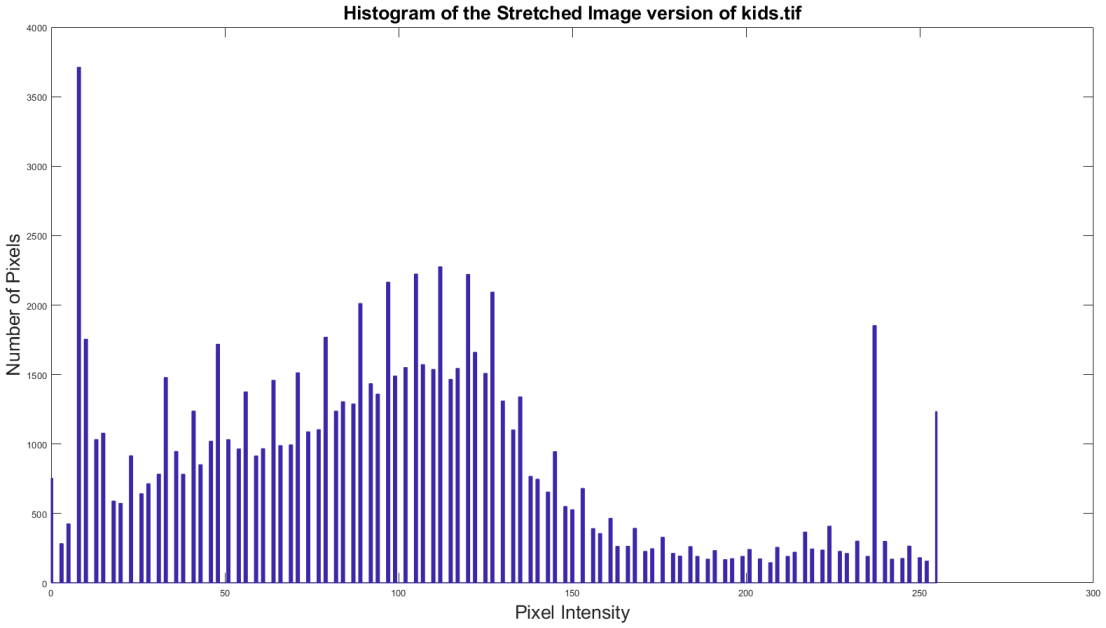
In this section, we have performed contrast stretching on the image, *kids.tif*

3.1 stretch.m

```
function [CS_image]=stretch(input_img,T1,T2)
    CS_image=zeros(size(input_img));
    idx=find(input_img > T1 & input_img < T2);
    CS_image(idx)=(input_img(idx)-T1)*(255/(T2-T1));
    CS_image(input_img>T2)=255;
    CS_image=uint8(CS_image);
end
```

3.2 Contrast Stretched Image

3.3 Histogram of the Contrast Stretched Image



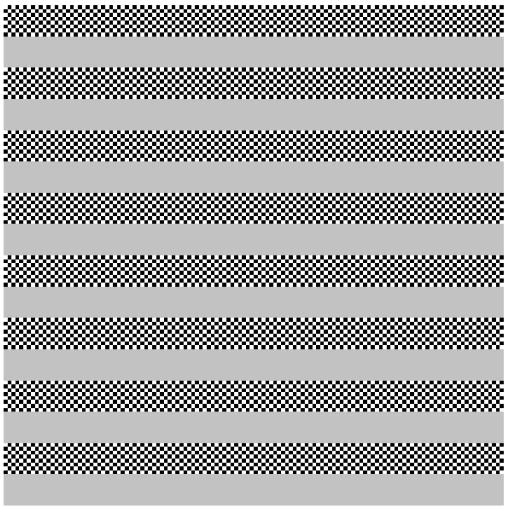
4 Gamma γ

4.1 checkerboard2.m

```
function [check]=checkerboard2(gray)
    mat=[255 255 0 0;255 255 0 0;0 0 255 255;0 0 255 255];
    gray_row=ones(16,256)*gray;
    check_row=repmat(mat,4,64);
```

```
    cg_row=[check_row;gray_row];
    check=repmat(cg_row,8,1);
    check=uint8(check);
end
```

4.2 Image Corresponding to gray level 195



4.3 Derivation of the Expression that relates the matching gray level to the value of γ

We know that,

$$I_c = \frac{I_2 55}{2}$$

Also,

$$I_g = I_2 55 * \left(\frac{g}{255}\right)^{\gamma}$$

But for matching gray levels, we know that:

$$I_c = I_g$$

Thus,

$$\frac{I_2 55}{2} = I_2 55 * \left(\frac{g}{255}\right)^{\gamma}$$

$$\gamma = -\frac{log 2}{log \frac{g}{255}}$$

But for the monitor, g=195 , we have:

$$\gamma = -\frac{log 2}{log \frac{195}{255}}$$

$$\gamma = 2.584$$

4.4 Gamma Correction

4.5 Formula for Image Transformation

We know that,

$$y = 255 * \left(\frac{x}{255}\right)^{\gamma}$$

$$x = 255 * \left(\frac{y}{255}\right)^{1/\gamma}$$

where 'x' is the Gamma corrected image.

4.6 Original Image *linear.tif*

4.7 Gamma Corrected Image *linear.tif* with $\gamma = 2.584$

4.8 Formula for Transformation of an Image with Gamma Correction

Consider 'x' to be an image.

Let's consider that 'x' is Gamma corrected with the value γ_1. Thus, the original image 'y' can be represented as,

$$y = 255 * \left(\frac{x}{255}\right)^{\gamma_1}$$

Now suppose 'y' undergoes another Gamma correction with a Gamma value, γ_2 to be transformed into image 'z'. 'z' can be represented as,

$$z = 255 * \left(\frac{y}{255}\right)^{1/\gamma_2}$$

Now 'z' can be expressed in terms of the original image as follows,

$$z = 255 * \left(\frac{x}{255}\right)^{\gamma 1/\gamma_2}$$

4.9 Original Image $gamma15.tif$

4.10 Transformed Image *gamma15.tif*

5 MATLAB Main Code

```
clear
close all
graymap = [0:255; 0:255; 0:255]'/255;

Irace=imread('race.tif');
figure
hist(Irace(:),[0:255])
xlabel('Pixel Intensity','FontSize',20)
ylabel('Number of Pixels','FontSize',20)
title('Histogram of the Image race.tif','FontSize',20)

Ikids=imread('kids.tif');
figure
hist(Ikids(:),[0:255])
xlabel('Pixel Intensity','FontSize',20)
ylabel('Number of Pixels','FontSize',20)
title('Histogram of the Image kids.tif','FontSize',20)

[Eqkids Cdf]=equalize(Ikids);
figure
plot(Cdf);
xlabel('Pixel Intensity','FontSize',20)
ylabel('$$\hat{F}_x(X_s)$$','FontSize',20)
title('CDF of Image kids.tif','FontSize',20)
figure
hist(Eqkids(:),[0:255]);
xlabel('Pixel Intensity','FontSize',20)
ylabel('Number of Pixels','FontSize',20)
title('Equalized Histogram of the Image kids.tif','FontSize',20)

[Eqrace Cdf]=equalize(Irace);
figure
```

```
plot(Cdf);
xlabel('Pixel Intensity','FontSize',20)
ylabel('F_x(X_s)','FontSize',20)
title('CDF of Image race.tif','FontSize',20)
figure
hist(Eqrace(:),[0:255]);
xlabel('Pixel Intensity','FontSize',20)
ylabel('Number of Pixels','FontSize',20)
title('Equalized Histogram of the Image race.tif','FontSize',20)

figure
imshow(Eqkids);
colormap(graymap);

stretch_kids=stretch(Ikids,70,170);
figure
imshow(stretch_kids)
colormap(graymap);

figure
hist(stretch_kids(:),[0:255])
xlabel('Pixel Intensity','FontSize',20)
ylabel('Number of Pixels','FontSize',20)
title('Histogram of the Stretched Image version of kids.tif','FontSize',20)

check=checkerboard2(195);
figure
imshow(check)
colormap(gray)

linImg=imread('linear.tif');
linImg_cor=255.*(double(linImg)/255).^(double(1/2.584));
figure
set(gca,'visible','off')
image(uint8(linImg_cor));
colormap(graymap);

gammaImg=imread('gamma15.tif');
gammaImg_cor=255.*(double(gammaImg)/255).^(double(1.5/2.584));
figure
image(uint8(gammaImg_cor));
colormap(graymap);
```