ECE 637 Lab 4 Report

Pointwise Operations and Gamma

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Section 1 – Histogram of an Image

1.1 The Sample Images and Their Labeled Histogram

Fig 1-1 Sample Image race.tif

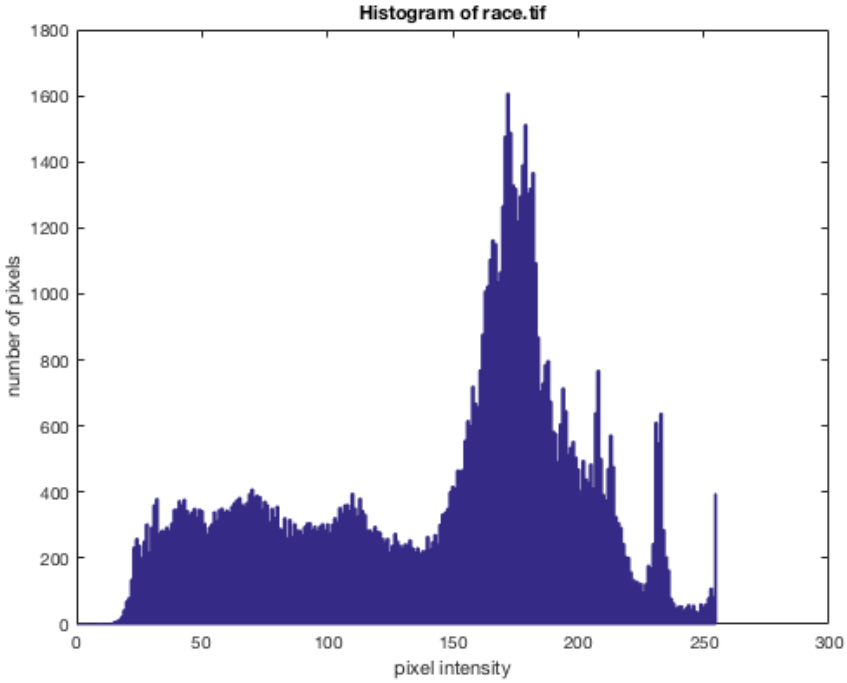

Fig 1-2 Histogram of race.tif

Fig 1-3 Sample Image kids.tif

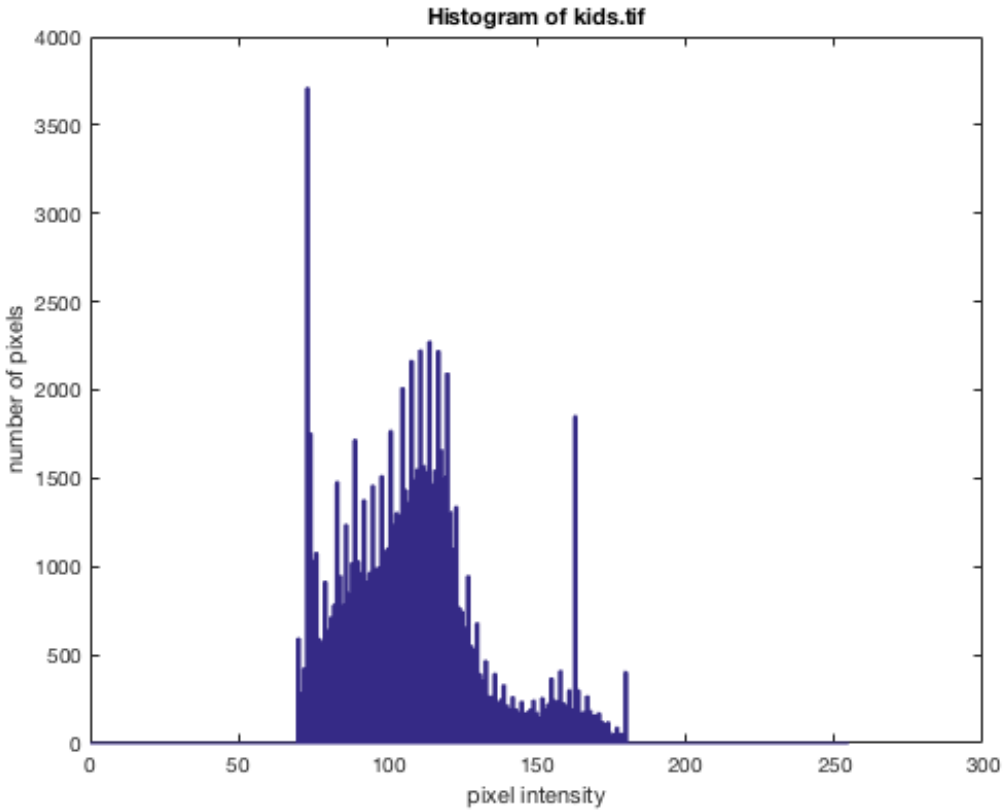

Fig 1-4 Histogram of kids.tif

Section 2 – Histogram Equalization

In this section, after equalization, the image is much clearer than the original one. The pixels were locating in interval [70,180] in the original image, but in the equalized image, the pixels are extending to [0, 255], and the histogram seems more uniform.

2.1 The Matlab Function *equalize.m*

```
function [Y] = equalize(X)
counts = hist(X(:),[0:255]);
total = sum(counts);
Y = counts; % 0 - 255
for (i=1:255)
    Y(i+1) = Y(i) + Y(i+1);
end
Y = Y./total;
Ymin = Y(min(X(:)));
Ymax = Y(max(X(:)));
Z = uint8(255*((Y(X) - Ymin)/(Ymax - Ymin)));

figure(1)
plot([0:255],Y);
xlabel('pixel intensity')
ylabel('Cumulative Distribution')
title('cumulative distribution function of kids.tif')
grid on
xlim([0, 255])
figure(2);
image(Z+1);
axis('image');
```

```
graymap = [0:255;0:255;0:255]'/255;
colormap(graymap);
figure(3)
hist(Z(:),[0:255])
xlabel('pixel intensity')
ylabel('number of pixels')
title('Histogram of equalized kids.tif')
xlim([0 255])

end
```

2.2 The Labeled Plot of $\widehat{F}_x(\mathrm{i})$ for the Image *kids.tif*

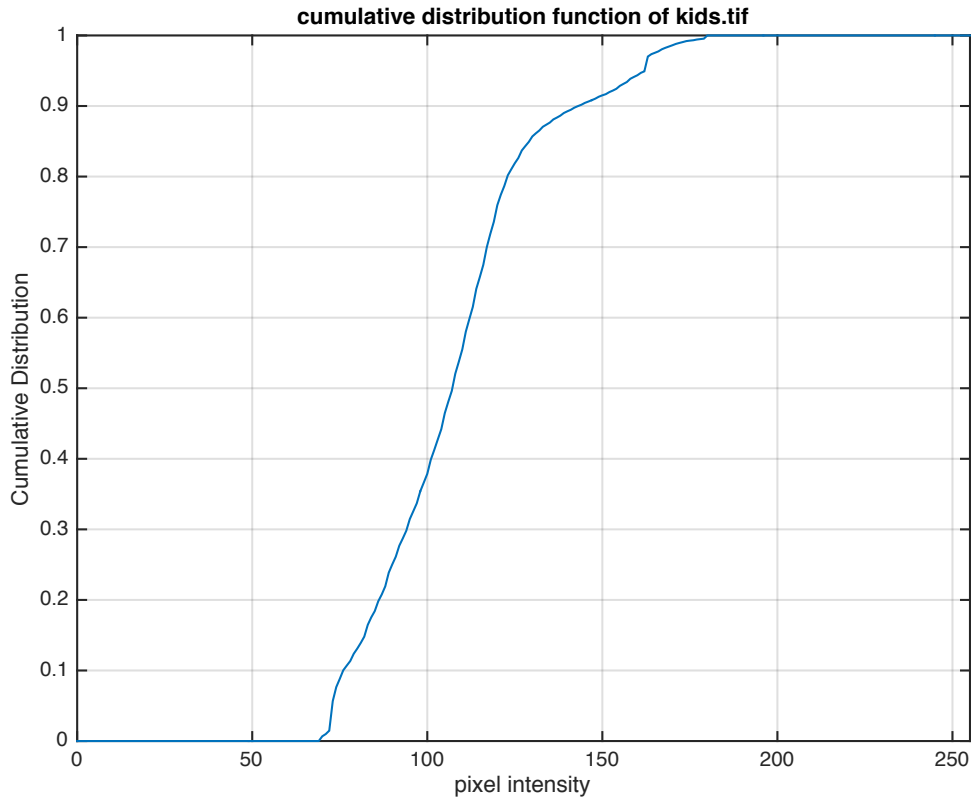

Fig 2-2 The Labeled Plot of $\widehat{F}_x(\mathrm{i})$ for the Image *kids.tif*

2.3 The Labeled Plot of the Equalized Image' s Histogram

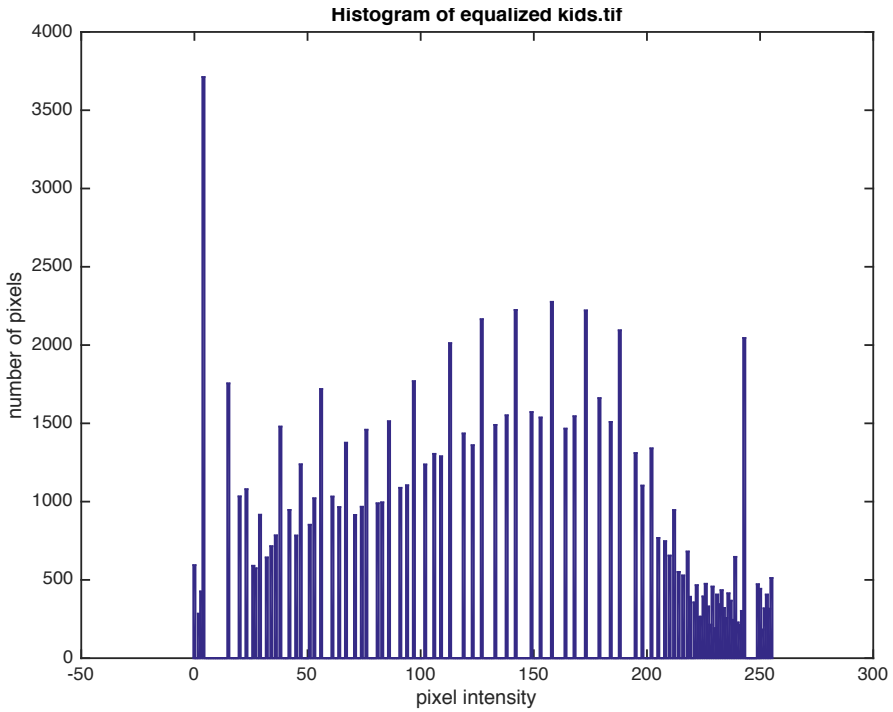

Fig 2-3 The Labeled Plot of the Equalized kids.tif' s Histogram

2.4 The Equalized Image

Fig 2-4 The Equalized kid_equ.tif

Section 3 – Contrast Stretching

3.1 The Matlab Function *stretch.m*

```
function output = stretch(input, T1, T2)
[m,n] = size(input);
output = zeros(m,n);
for (i=1:m)
    for (j=1:n)
        if (input(i,j) < T1)
            output(i,j) = uint8 (0);
        elseif (input(i,j) > T2)
            output(i,j) = uint8 (255);
        else
            output(i,j) = uint8 (255 / (T2-T1) * (input(i,j)-T1));
        end
    end
end

figure(1);
image(output+1);
axis('image');
graymap = [0:255;0:255;0:255]'/255;
colormap(graymap);
figure(2)
hist(output(:),[0:255])
xlabel('pixel intensity')
ylabel('number of pixels')
title('Histogram of stretched kids.tif')
xlim([0 255])
end
```

3.2 The Transformed Image and Its Histogram

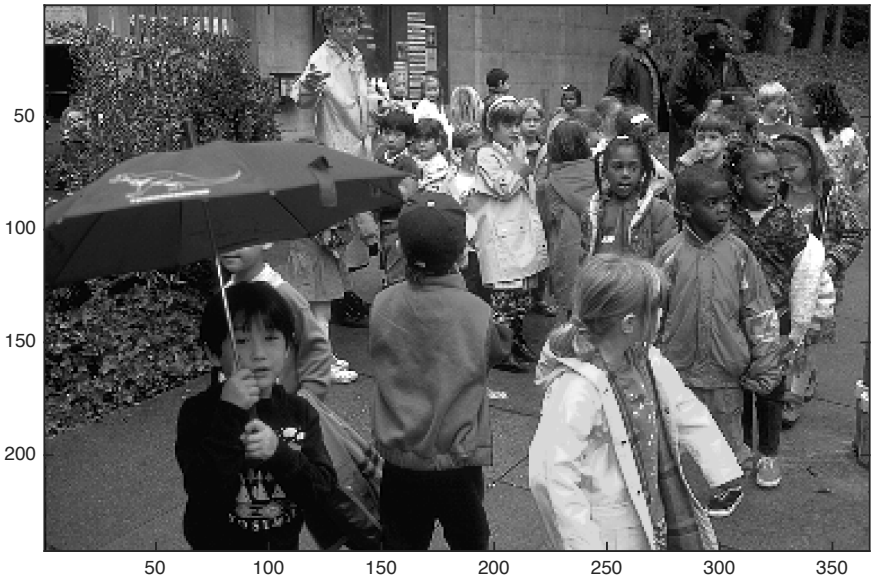

Fig 3-2 The Transformed Image of *kids_trans.tif*

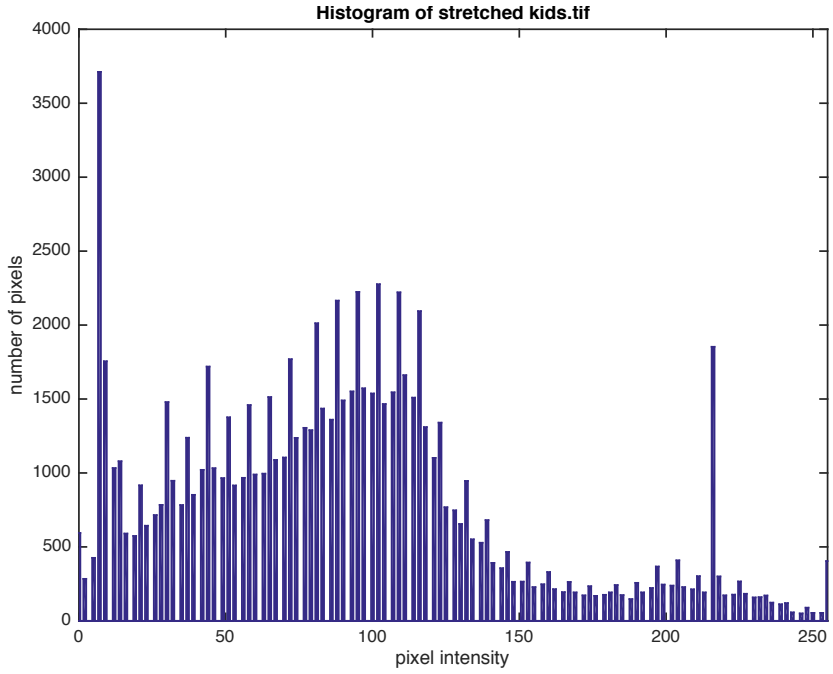

Fig 3-3 The Stretched Image Histogram

In this section, I choose T1 = 70, and T2 = 180, then the stretched image is much clearer than the original one. Also the histogram is stretched from [70, 180] to [0, 255].

Section 4 – Gamma (γ)

Section 4.2 Determining the Gamma of Your Computer Monitor

4.2.1 The Image Corresponding to the Matching Gray Level

Matching gray level = 190 on my monitor.

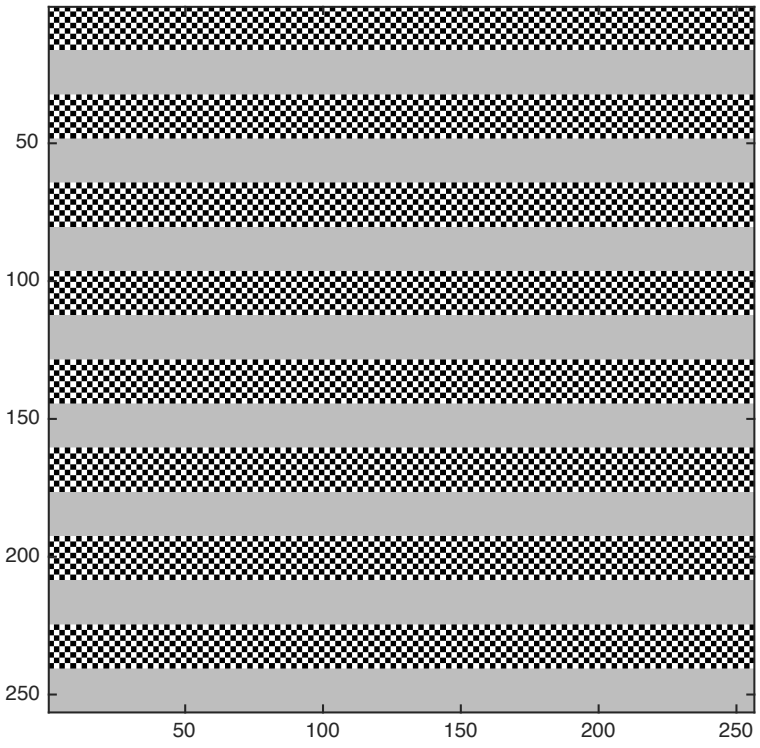

Fig 4-2-1 The Image Corresponding to the Matching Gray Level

4.2.2 Derivation of the Expression Which Relates the Matching Gray Level to the value of γ

We know that $I_c = \frac{I_{255}+0}{2}$, and $I_g = I_{255}(\frac{g}{255})^{\gamma}$.

Then for matching case, if $I_c = I_g$, then $\frac{I_{255}+0}{2} = I_{255}(\frac{g}{255})^{\gamma}$.

If we divide by I_{255} on both side, we get $\frac{1}{2} = (\frac{g}{255})^{\gamma}$.

Then take log on both side, we get

$$\log\left(\frac{1}{2}\right) = -\log(2) = \log\left(\left(\frac{g}{255}\right)^{\gamma}\right) = \gamma \cdot \log(\frac{g}{255})$$

Then we can get

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

4.2.3 The Values of the Measured Gray Level and the measured γ

In my case, g=190, therefor, $\gamma = -\frac{\log(2)}{\log(\frac{190}{255})} = 2.3557$

Section 4.3 Gamma Correction

4.3.1 The Original and Corrected Images

Fig 4-3-1-1 The Original Image

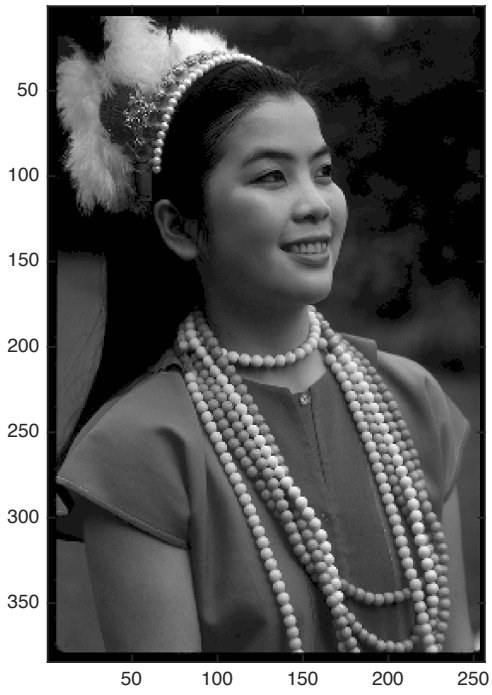

Fig 4-3-1-2 The Corrected Image

4.3.2 The Formula Used to Transform the Original Image

We have $I_g = I_{255}(\frac{g}{255})^{\gamma}$, then we can get $g = 255(\frac{I_g}{I_{255}})^{\frac{1}{\gamma}}$, and use this formula to correct image.

4.3.3 The Procedure Used to Change the Gamma Correction of the Original Image

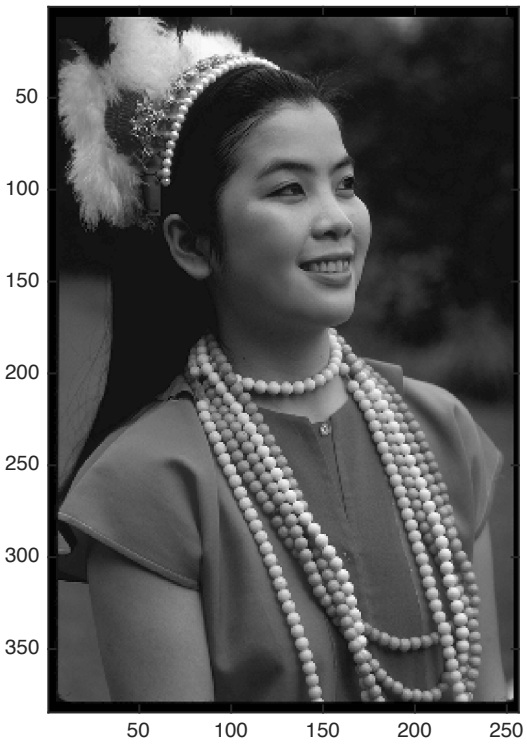

Fig 4-3-3 The Corrected Image of *gamma15.tif*

Since *gamma15.tif* is already gamma corrected for $\gamma = \frac{1}{1.5}$, therefore, we need to apply the gamma correction function oppositely, and get the original image by applying $g = 255(\frac{I_g}{I_{255}})^{1.5}$

Then change $\gamma = 2.3557$, and apply the gamma correction again, by using $g = 255(\frac{I_g}{I_{255}})^{\frac{1}{2.3557}}$.