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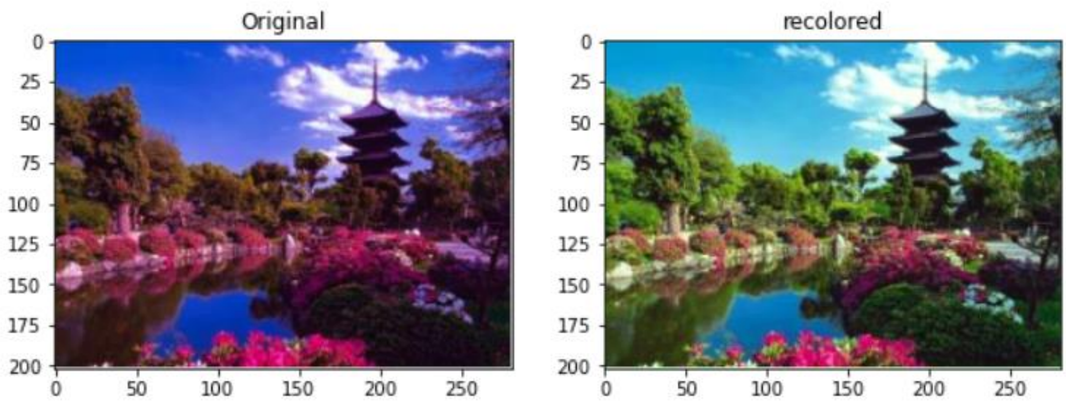
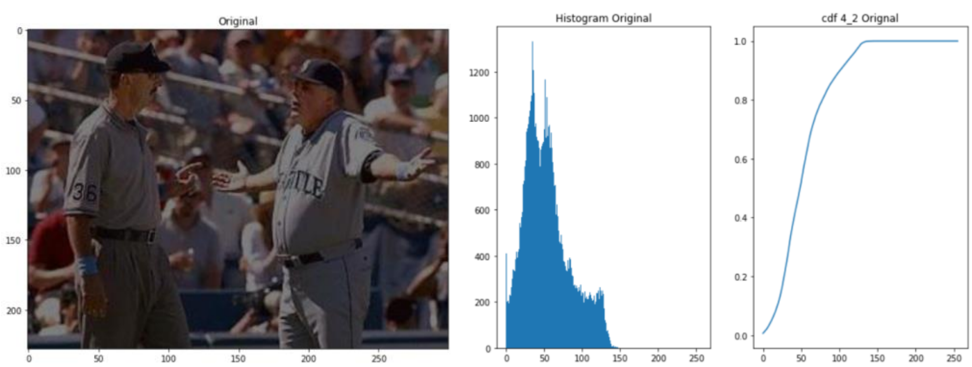
EE 440 HW4 Report

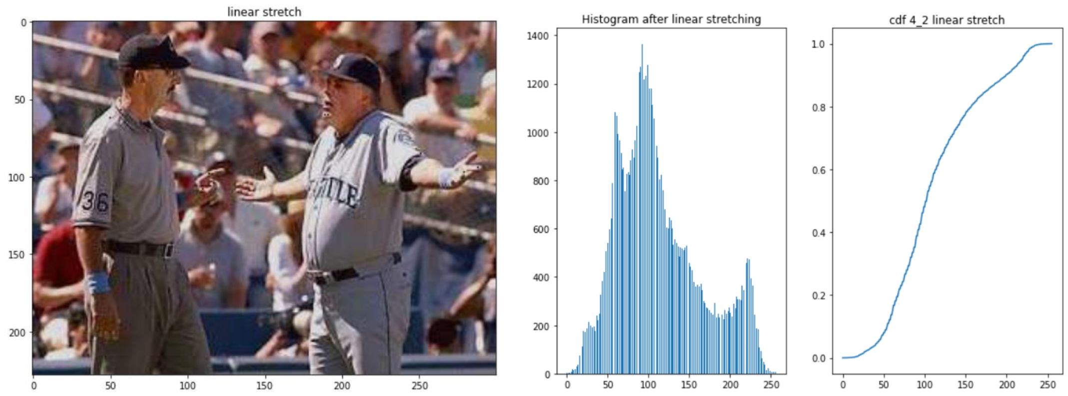
1. In this problem, we are trying to change the color tone of the image. From the original image, we observe that the color is heavy in magenta; therefore, Specifically, I inverted the RGB values to produce the CMY channel value, I decided to weaken the magenta tone using power-law transform. By trying different values for gamma constant, I found gamma = 2.5 produces a result pretty similar to what was given in the specification. The results are shown below.

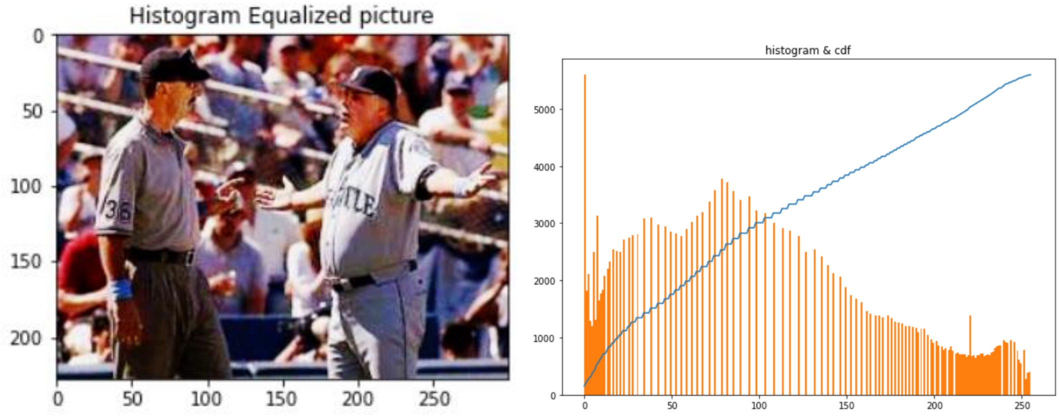


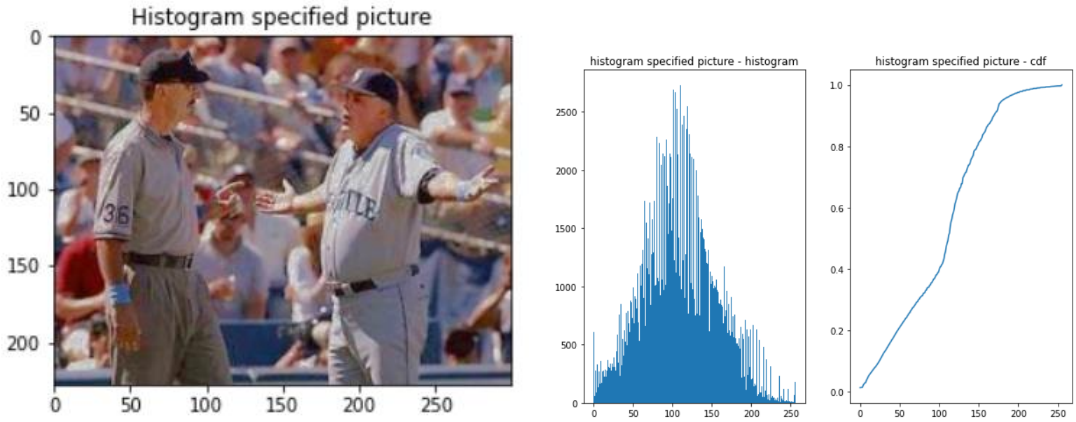
2. In this part, we were asked to investigate the ability of image enhancement of three different methods, the linear stretching, the histogram equalization, and the histogram specification. For each of 4_2.jpg and 4_3.jpg, I first displayed the original images, converted them to HSV scale, and generated their histogram and cdf plot. From there, for linear stretch, I expanded stretches the original min to 0 and original max to 255. For histogram equalization, I performed mapping so that the number of pixels corresponding to each color value spread more evenly. For the histogram specification, I used Gaussian distribution for mapping and redistributed the histogram to a more normalized shape. The original images and the results of three different enhancements are shown as below.

4_2:

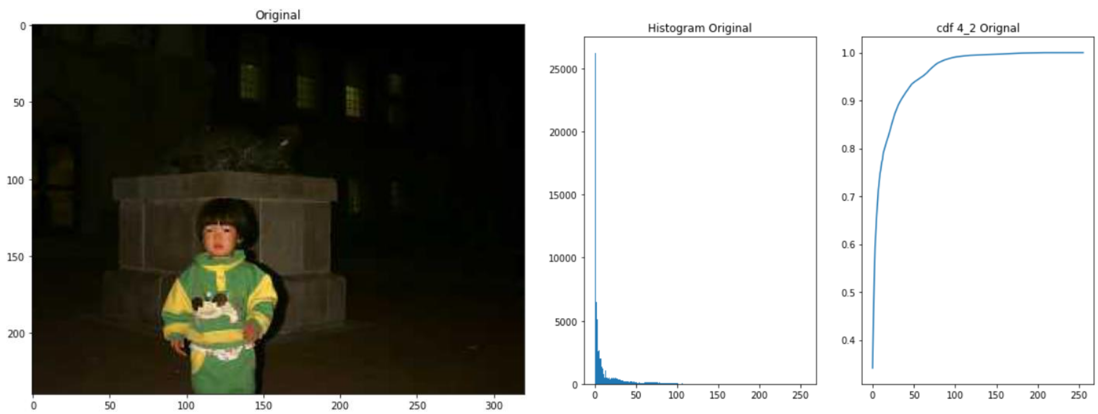


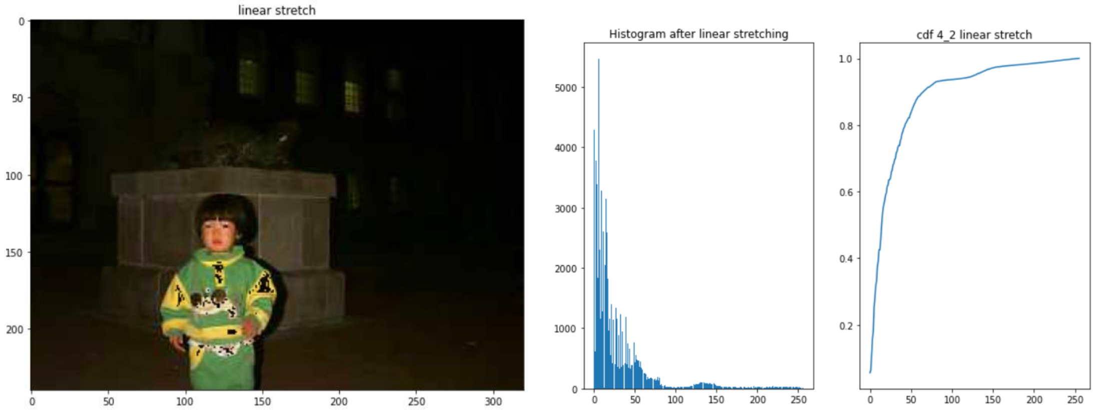

linear stretch
Histogram after linear stretching
cdf 4_2 linear stretch

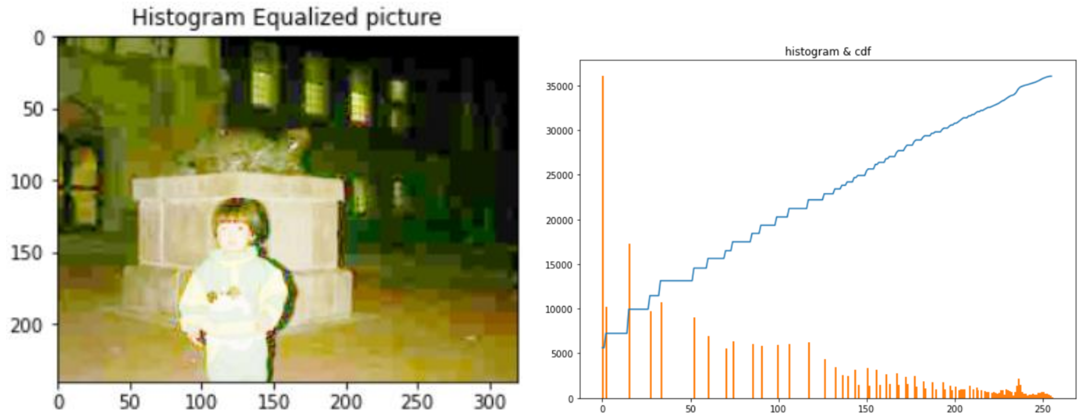

Histogram Equalized picture
histogram & cdf

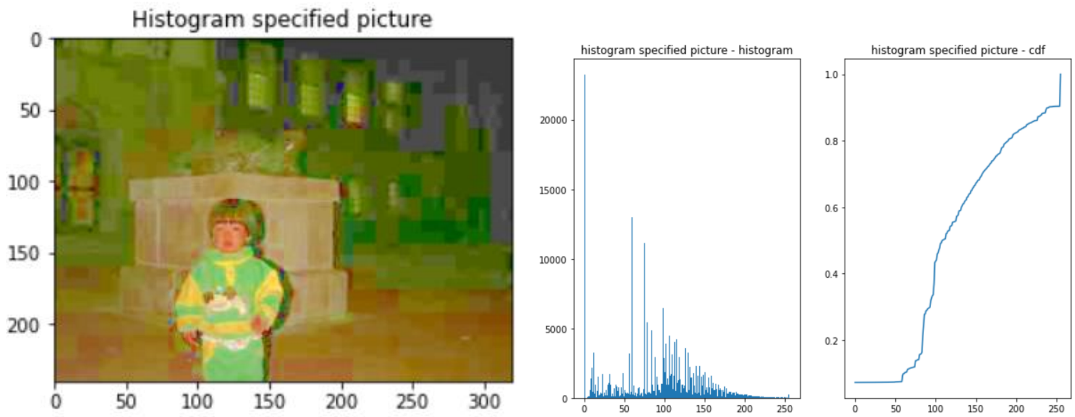

Histogram specified picture
histogram specified picture - histogram
histogram specified picture - cdf

4_3:


Original
Histogram Original
cdf 4_2 Orignal







As we can see, for 4_2, both histogram specification and linear stretch performed a good enhancement, while linear stretch seems to have a higher contrast in colors than the histogram specification picture. However, for 4_3, none of the methods worked perfectly. Linear stretch was relatively better, while the histogram equalization and histogram specification produced weird blocky pixels, lighting and color tone in the background and makes it unnatural.

Screenshots of the code will be listed in the APPENDIX below.

APPENDIX:

I.

```
# This is the import cell
import numpy as np
import cv2
import matplotlib.pyplot as plt
from skimage import color
```

```
# Problem 1 Image Color Adjustment

# to display multiple pictures
fig1 = plt.figure(figsize=(10, 7))

# read and show the image 4_1.bmp scenery
fig1.add_subplot(1, 2, 1)
scenary = plt.imread('4_1.bmp')
plt.imshow(scenary)
plt.title("Original")

# get shape for following temperary pixel size
print(np.shape(scenary))

# convert the image to CMY
CMY = 255 * np.ones((202, 282, 3)) - scenary

# extract the magenta channel
M = CMY[:, :, 1]

# produce lower magenta and replace it in the image
weak_M = (M / 255) ** 2.5 * 255
weak_scenary = CMY
weak_scenary[:, :, 1] = weak_M
weak_scenary = (255 * np.ones((202, 282, 3)) - weak_scenary) / 255

# display the recorlored image
fig1.add_subplot(1, 2, 2)
plt.imshow(weak_scenary)
plt.title("recolored")
```

II.

```python
# Problem 2 Image enhancement
def plotOriginal(pic):
    # read in the picture and display the original image
    image =  plt.imread(pic)
    fig2 = plt.figure(figsize=(10, 7))
    plt.imshow(image)
    plt.title("Original")

    # convert image1 to hsv
    hsv = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)

    # extract v and display its histogram
    v = image[:, :, 2]
    fig3 = plt.figure(figsize=(10, 7))
    fig3.add_subplot(1, 2 , 1)
    hist = plt.hist(v.flatten(), 256, [0, 256])
    plt.title("Histogram Original")

    # create pdf function
    pdf = np.zeros(256)
    for i in range(256):
        # probability = value / size
        pdf[i] = hist[0][i] / (v.shape[0] * v.shape[1])

    # create cdf function
    cdf = np.cumsum(pdf)
    fig3.add_subplot(1, 2, 2)
    plt.plot(cdf)
    plt.title("cdf 4_2 Orignal")
    plt.show()
```

```python
def linearStretch(pic):
    # to obtain the HSV's v channalboundary X, Y
    image = plt.imread(pic)
    hsv = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)
    v = image[:, :, 2]
    x = np.min(v)
    y = np.max(v)

    # perform linear stretch: (pixel_value - min) / (max - min) * 255
    hsv[:, :, 2] = ((hsv[:, :, 2] - x) / (y - x)) * 255
    v_ls = hsv[:, :, 2]

    # convert image back to RGB
    ls_new = cv2.cvtColor(hsv, cv2.COLOR_HSV2BGR)
    fig4 = plt.figure(figsize=(10, 7))
    plt.imshow(ls_new)
    plt.title("linear stretch")

    # display the output image's histogram
    fig5 = plt.figure(figsize=(10, 7))
    fig5.add_subplot(1, 2, 1)
    hist_ls = plt.hist(v_ls.flatten(), 256, [0, 256])
    plt.title("Histogram after linear stretching")

    # create pdf function
    pdf_ls = np.zeros(256)
    for i in range(256):
        # probability = value / size
        pdf_ls[i] = hist_ls[0][i] / (v_ls.shape[0] * v_ls.shape[1])

    # create cdf function
    cdf_ls = np.cumsum(pdf_ls)
    fig5.add_subplot(1, 2, 2)
    plt.plot(cdf_ls)
    plt.title("cdf 4_2 linear stretch")
    plt.show()
```

```python
def histEqualization(pic):
    # read in the original picture and convert it to hsv scale
    image = plt.imread(pic)
    hsv = cv2.cvtColor(image,cv2.COLOR_BGR2HSV)

    # generate the original histogram and cdf
    hist, bins = np.histogram(hsv[0::, 0::, 2].flatten(), 256, [0,256])
    cdf = hist.cumsum()
    cdf_norm = cdf * (hist.max() / cdf.max())

    # mapping
    cdf_eq = (cdf - cdf.min()) / (cdf.max() - cdf.min())  * 255

    # integer conversion
    img_eq = cdf_eq[image]
    for x in range(img_eq.shape[0]):
        for y in range(img_eq.shape[1]):
            img_eq[x, y, 2] = int(img_eq[x,y,2])

    # generate new histogram
    hist_eq, bins_eq = np.histogram(img_eq.flatten(), 256, [0,256])
    img_eq = img_eq.astype('uint8')
    # generate new cdf
    cdf_eq = hist_eq.cumsum()
    cdf_eq_norm = cdf_eq * (hist_eq.max() / cdf_eq.max())

    # display the orginal and after histogram equalization
    fig6 = plt.figure(figsize=(10, 7))
    fig6.add_subplot(1, 2, 1)
    plt.title("Original")
    plt.imshow(image)

    fig6.add_subplot(1, 2, 2)
    plt.title("Histogram Equalized picture")
    plt.imshow(img_eq)

    # display cdf and histogram
    fig7 = plt.figure(figsize=(10, 7))
    fig7.add_subplot(1, 2, 1)
    plt.plot(cdf_eq_norm)
    plt.title("histogram equalized picture - cdf")
```

```python
    fig7.add_subplot(1, 2, 2)
    plt.hist(img_eq.flatten(), 256, [0,256])
    plt.title("histogram equalized picture - histogram")
    plt.show()
```

```python
def close(List, k):
    return min(range(len(List)), key = lambda i:abs(List[i] - k))

def histSpecification(pic):
    # read in the original picture and convert it to hsv scale
    image = plt.imread(pic)
    hsv = cv2.cvtColor(image,cv2.COLOR_BGR2HSV)

    # generate histogram and cdf for the original image
    v = hsv[:, :, 2]
    hist, bins = np.histogram(v.flatten(), 256, [0, 256])
    cdf = hist.cumsum()

    # create gaussian distribution for mapping
    gauss = np.random.normal(loc = 255/2, scale = 255/6, size = hsv.shape[0]*hsv.shape[1])
    hist_gauss, bins_gauss = np.histogram(gauss.flatten(), 256, [0,256])
    cdf_gauss = hist_gauss.cumsum()

    # redistribute the histogram
    image2 = hsv
    for i in range(0, image2.shape[0]):
        for j in range(0, image2.shape[1]):
            # obtain the cdf value for the given pixel's gray scale value
            cdf_value = cdf[image2[i, j, 2]]
            cdf_gauss_value = close(cdf_gauss, cdf_value)
            image2[i, j, 2] = cdf_gauss_value
```

```
    # generate new image's histogram and cdf
    hist_spc, bins_spc = np.histogram(image2.flatten(), 256, [0, 256])
    pdf_spc = hist_spc / sum(hist_spc)
    cdf_spc = pdf_spc.cumsum()

    image_spc = cv2.cvtColor(image2, cv2.COLOR_HSV2BGR)

    # display the orginal and after histogram equalization
    fig8 = plt.figure(figsize=(10, 7))
    fig8.add_subplot(1, 2, 1)
    plt.title("Original")
    plt.imshow(image)

    fig8.add_subplot(1, 2, 2)
    plt.title("Histogram specified picture")
    plt.imshow(image_spc)

    # display cdf and histogram on the same plot
    fig9 = plt.figure(figsize=(10, 7))
    fig9.add_subplot(1, 2, 1)
    plt.hist(image_spc.flatten(), 256, [0,256])
    plt.title("histogram specified picture - histogram")
    fig9.add_subplot(1, 2, 2)
    plt.plot(cdf_spc)
    plt.title("histogram specified picture - cdf")
    plt.show()
```

```
# i. 4_2 enhancement
img1 = '4_2.jpeg'
plotOriginal(img1)
linearStretch(img1)
histEqualization(img1)
histSpecification(img1)
```

```
# i. 4_3 enhancement
img2 = '4_3.jpeg'
plotOriginal(img2)
linearStretch(img2)
histEqualization(img2)
histSpecification(img2)
```