Histogram Equalization

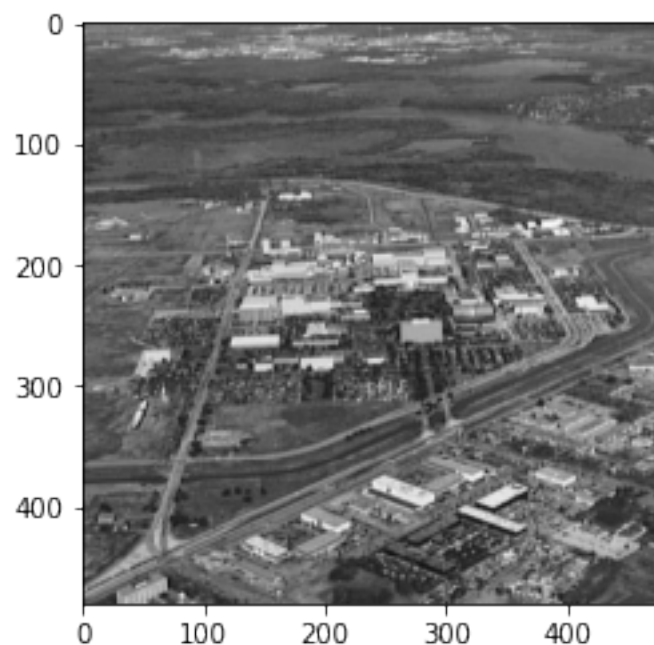March 27, 2021

1   Histogram Equalization

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```
[1]: %matplotlib inline
```

```
[2]: from IPython.display import display, Math, Latex
     import numpy as np
     import matplotlib.pyplot as plt
     from PIL import Image
```
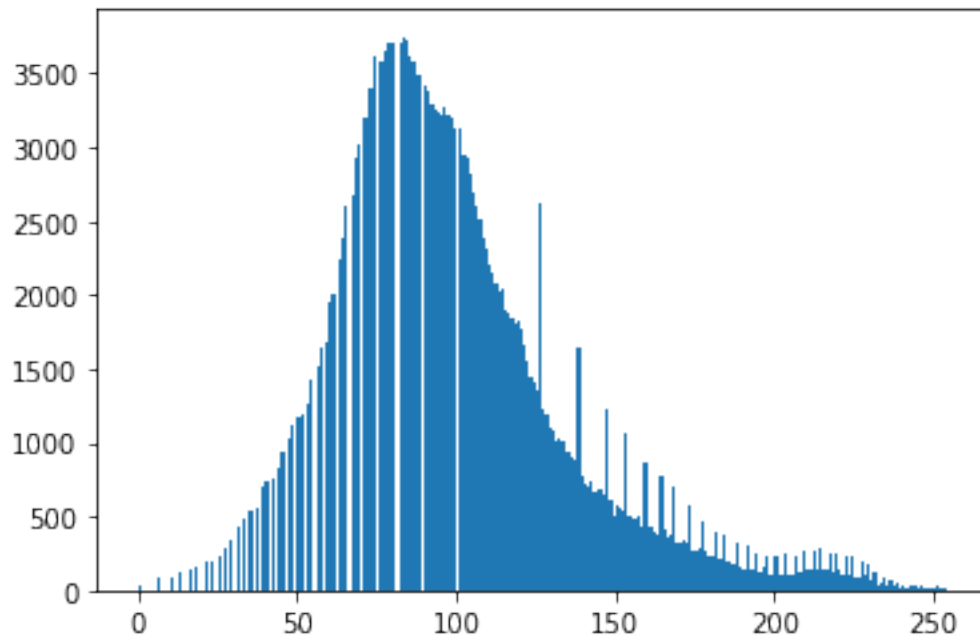
1.1   Original Image

```
[3]: img = Image.open('aerial_view.tif')
     _ = plt.imshow(img, cmap='gray')
```
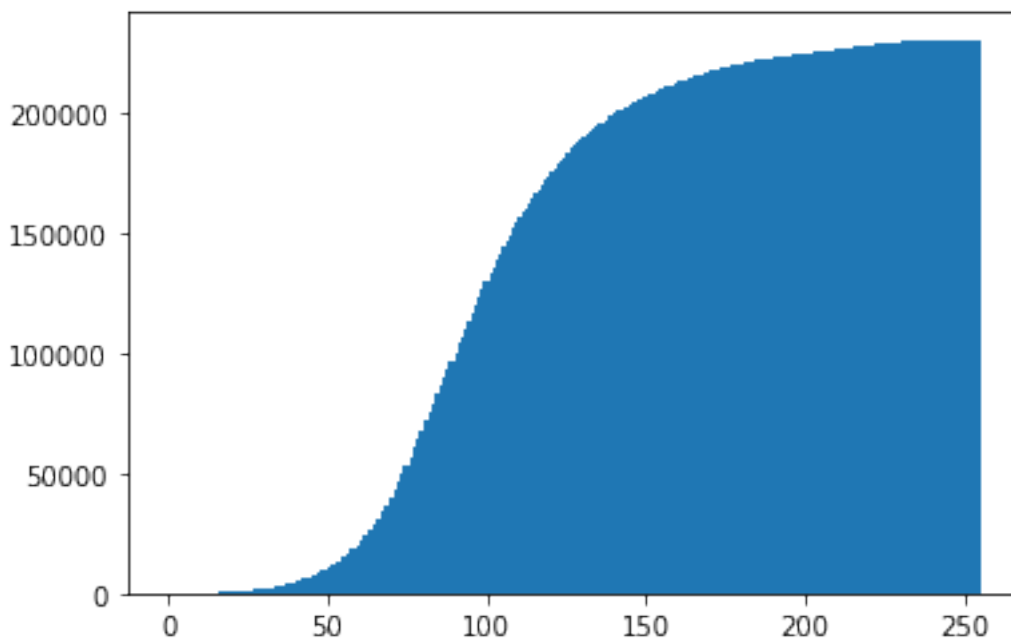
1.2 Histogram (count/cumulative sum to intensity) of Original Image

```
[4]:  # convert our image into a 1d numpy array and show statistics
      img = np.asarray(img)
      flat = img.flatten()
      # hist = np.histogram(flat, bins=range(256))[0]
      stats = plt.hist(flat, bins=range(256), cumulative=0)[0]
```



```
[5]:  cumulative_sum = plt.hist(flat, bins=range(256), cumulative=1)[0]
```
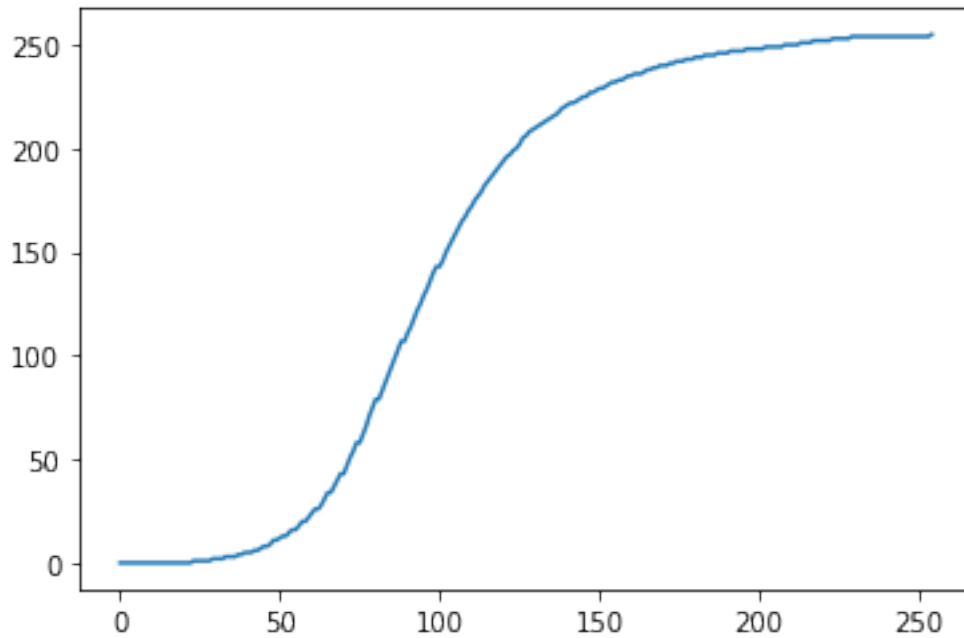
2

1.3 Building the Discrete Histogram Equalization transformation T

- $s = T(r) = (L-1)\int\limits_{0}^{r} p_r(w)dw$, discrete version

```
[6]: # $s = T(r) = (L-1)\int\limits_{0}^{r}p_r(w) dw$, discrete version
     rng = len(flat)
     # an alternative for $M*N$
     """
     minv = cumulative_sum.min()
     rng = cumulative_sum.max()-cumulative_sum.min()
     T = ((cumulative_sum-minv)/rng*255).astype('uint8')
     """
     T = (cumulative_sum/rng*255).astype('uint8')
```

```
[7]: plt.plot(T)
```

```
[7]: [<matplotlib.lines.Line2D at 0x272766cf760>]
```

3

1.4 Applying T to the Original Image
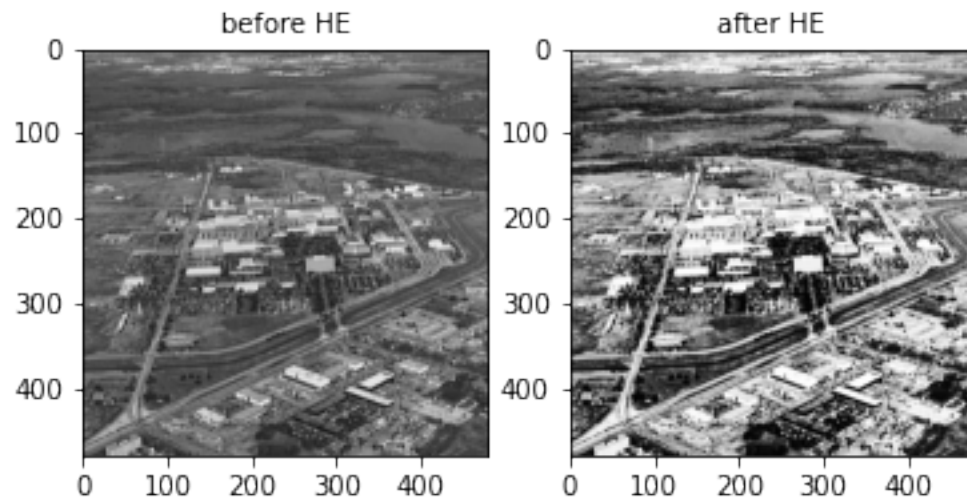
```
[8]: img_he = T[img]
```

```
[13]: fig = plt.figure()
      fig.suptitle("the comparison of histograms before/after HE", fontsize=15)

      fig.add_subplot(1,2,1)
      plt.imshow(img, cmap='gray')
      plt.title("before HE", fontsize=10)

      fig.add_subplot(1,2,2)
      plt.imshow(img_he, cmap='gray')
      _ = plt.title("after HE", fontsize=10)
```

## the comparison of histograms before/after HE


```
[12]: fig = plt.figure()
      fig.suptitle("the comparison of histograms before/after HE", fontsize=15)

      fig.add_subplot(1,2,1)
      plt.hist(flat, bins=range(256))
      plt.title("before HE", fontsize=10)

      fig.add_subplot(1,2,2)
      plt.hist((img_he.flatten()), bins=range(256))
      _ = plt.title("after HE", fontsize=10)

      plt.show(block=True)
```

the comparison of histograms before/after HE
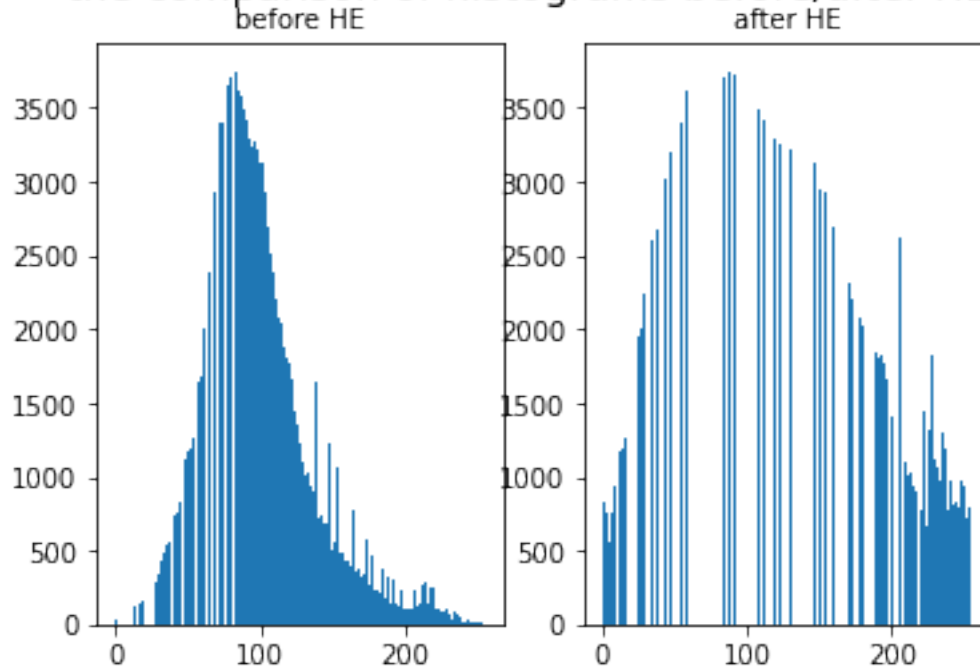
1.5 Comments on the comparison

Similar to the examples in the textbook, we have the distribution of the histogram-equalized picture being closer to a uniform distribution. This results in an enhancement of image contrast