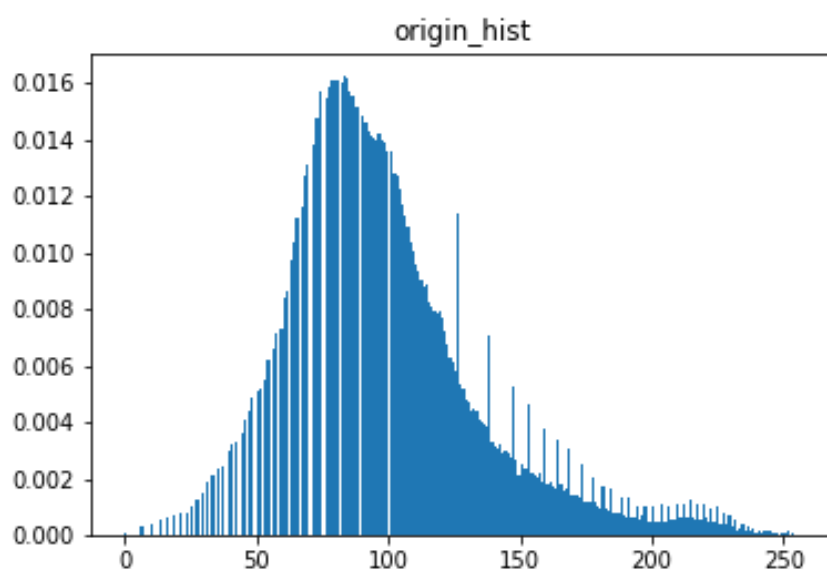# 1. Original image
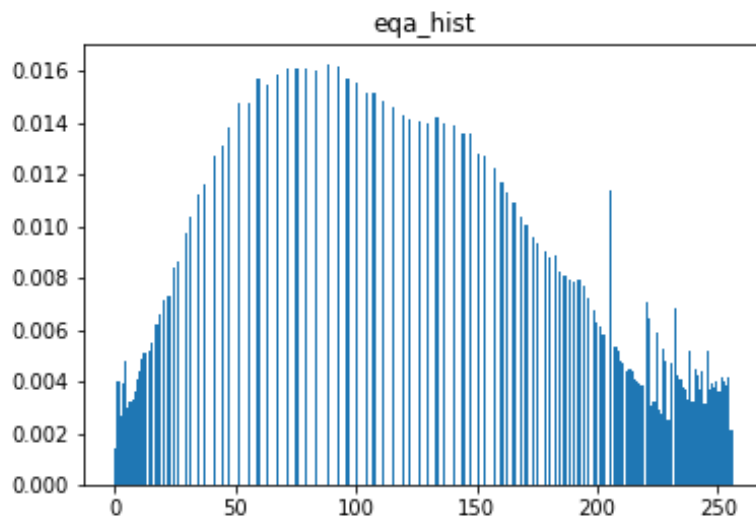
Graph

Histogram

Source code

```python
import cv2
import numpy as np
import matplotlib.pyplot as plt
img = cv2.imread('aerial_view.tif',cv2.IMREAD_GRAYSCALE)
cv2.imwrite('origin.jpg',img)
img2 = img.flatten()
plt.hist(img2,256,[0,256],density=True)
plt.title('origin_hist')
plt.savefig('origin_hist.png')
plt.show()
```

2.Histogram Equalization

Graph

Histogram

Source code

```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread('aerial_view.tif',cv2.IMREAD_GRAYSCALE)
img_flat = img.flatten()
img_eq = np.zeros([480,480])
hist_eqa = np.zeros([256])
mn = len(img_flat)
for i in img_flat:
    hist_eqa[i] += 1.0/mn
for i in range(1,len(hist_eqa)):
    hist_eqa[i] = hist_eqa[i-1] + hist_eqa[i]
hist_eqa = np.around(255*hist_eqa)

for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        img_eq[i,j] = hist_eqa[img[i,j]]

cv2.imwrite('eqa.jpg',img_eq)
plt.hist(img_eq.flatten(),256,[0,256],density=True)
plt.title('eqa_hist')
plt.savefig('eqa_hist.png')
plt.show()
```
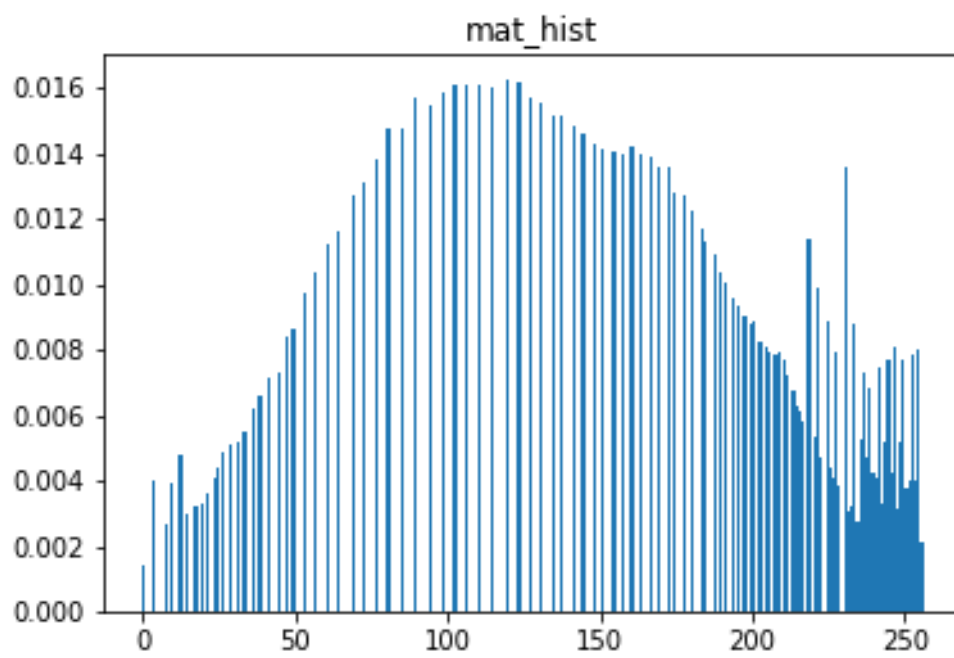
3.Histogram matching

Graph

Histogram

mat_hist

Source code

```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread('aerial_view.tif',cv2.IMREAD_GRAYSCALE)
img_flat = img.flatten()
img_eq = np.zeros([480,480])
hist_eqa = np.zeros([256])
mn = len(img_flat)

for i in img_flat:
    hist_eqa[i] += 1/mn
for i in range(1,len(hist_eqa)):
    hist_eqa[i] = hist_eqa[i-1] + hist_eqa[i]
hist_eqa = np.around(255*hist_eqa)

for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        img_eq[i,j] = hist_eqa[img[i,j]]

img_mat = np.zeros([480,480])
hist_mat = np.zeros([256])
z = 0
for i in range(256):
    z = z + pow(i,0.4)
c = 1/z
for i in range(1,len(hist_mat)):
    hist_mat[i] = hist_mat[i-1] + c*pow(i,0.4)
hist_mat = np.around(255*hist_mat)

temp = np.zeros([256])
z_index = 0
for i in range(256):
    while hist_eqa[i] > hist_mat[z_index]:
        z_index += 1
        if z_index > 255:
            z_index = 255
            break
    temp[i] = z_index
for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        img_mat[i,j] = temp[int(img[i,j])]

cv2.imwrite('mat.jpg',img_mat)
plt.hist(img_mat.flatten(),256,[0,256],density=True)
plt.title('mat_hist')
plt.savefig('mat_hist.png')
plt.show()
```

4.Comment

由結果可發現，原始圖片的 Histogram 主要分布在灰階 50~125 之間。經過
Histogram Equalization 之後，分布變得較為平滑，對比度也有提高。但灰階 200
後仍然擁擠。在經過 matching 之後，灰階 200 之後也變平滑且值提高，使整體

更加平滑。