






CS 314

IMAGE PROCESSING PRACTICAL

05 – Intensity Transformations

Basic Gray Level Transformations

Image Negative

$$T(r) = L - 1 - r$$

(L-1) → max intensity value

r → current pixel intensity value

```
##grayscale
img = cv2.imread(r'images\meter1.jpg',0)

#method 1
#using logical NOT
not_ = cv2.bitwise_not(img)

#method 2 - i
#Subtract the img from max value (dtype)
img3 = 255-img

#method 2 - ii
img4 = img.copy()
for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        img4[i,j] = 255-img4[i,j]
```

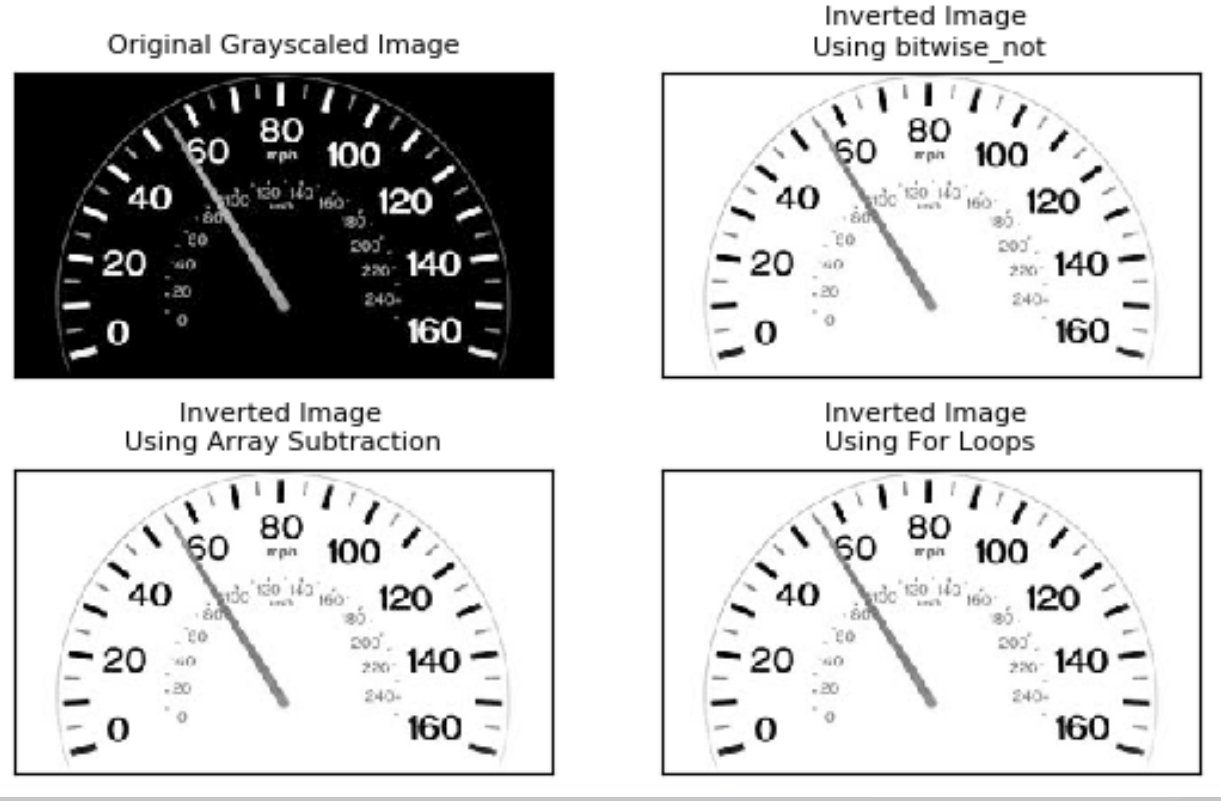


Image Brightness – Grayscale Images

```
img = cv2.imread(r'images\graylevel6.jpg',cv2.IMREAD_GRAYSCALE)

##using addition (for grayscale images)
img2 = img.copy()
img2 = cv2.add(img2,100)

def increase_brightness_gray(img, value=80):
    #handling value overflow
    lim = 255 - value
    img[img > lim] = 255
    img[img <= lim] += value

    return img
```

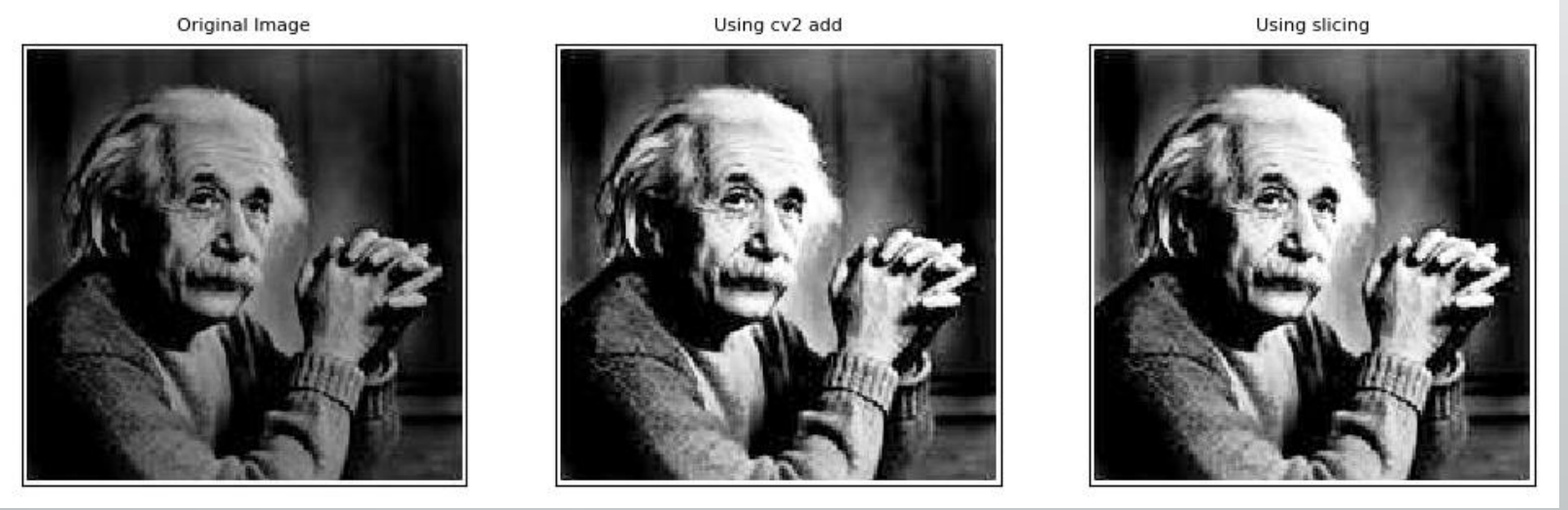


Image Brightness – Color Images

```
img1 = cv2.imread(r'images\messi5.jpg',cv2.IMREAD_COLOR)

##using hsv mode v channel
def increase_brightness_color(img, value=80):
    hsv = cv2.cvtColor(img, cv2.COLOR_BGR2HSV)
    h, s, v = cv2.split(hsv)

    #handling value overflow
    lim = 255 - value
    v[v > lim] = 255
    v[v <= lim] += value

    img4 = hsv.copy()
    for i in range(img.shape[0]):
        for j in range(img.shape[1]):
            if img4[i,j,2] + value > 255:
                img4[i,j,2] = 255
            else:
                img4[i,j,2] += value

    final_hsv = cv2.merge((h, s, v))

    return img,img4

img_m2,img_m3 = increase_brightness_color(img1, value=100)
```

Original Image

Using HSV v slicing

Using for loops

Log Transformations

```
img = cv2.imread(r'images\meter1.jpg',cv2.IMREAD_GRAYSCALE)

# Apply log transformation method with scaling constant
c = 255 / np.log(1 + np.max(img))
log_img_ = c * (np.log(img + 1))

#plain log transformation
log_img = np.log(img + 1)
log_img = np.array(log_img,dtype=np.uint8)
# converting float values into int
log_image1 = np.array(log_img, dtype = np.uint8)
log_image2 = np.array(log_img_, dtype = np.uint8)
```

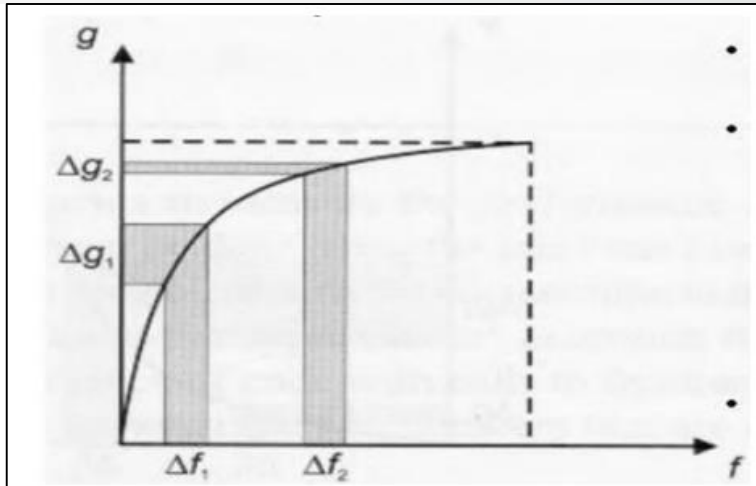
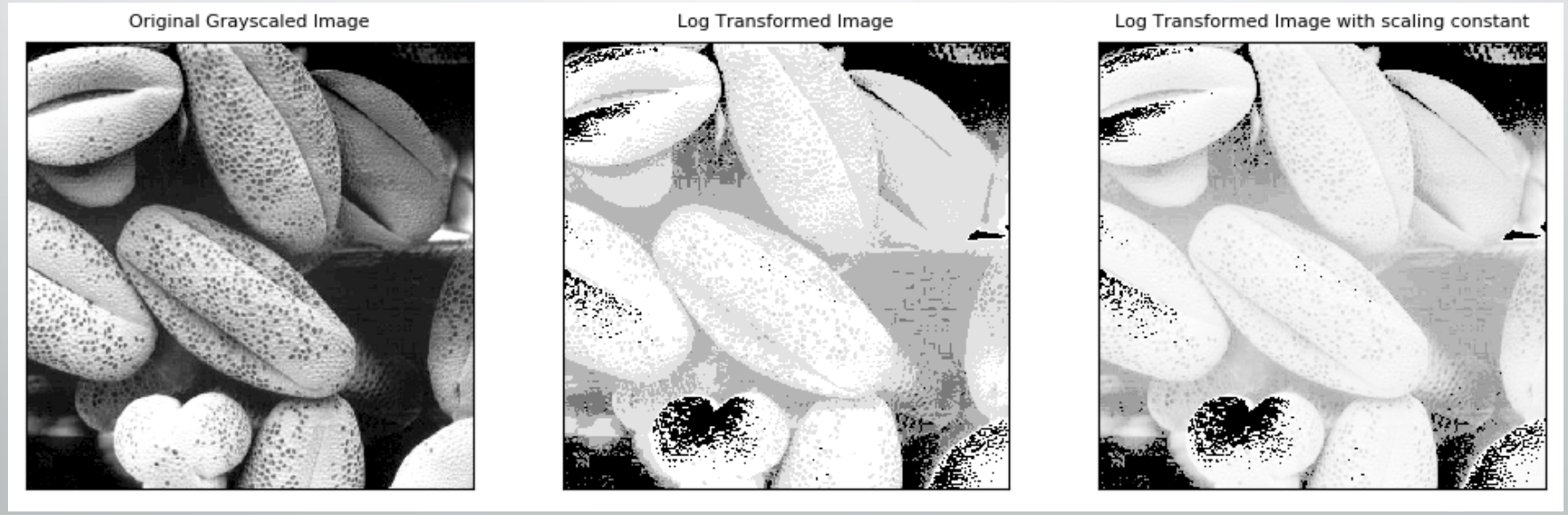


Fig. log transformation curve input vs output

Ref. https://www.geeksforgeeks.org/log-transformation-of-an-image-using-python-and-opencv/

Enhance the grey values in the image

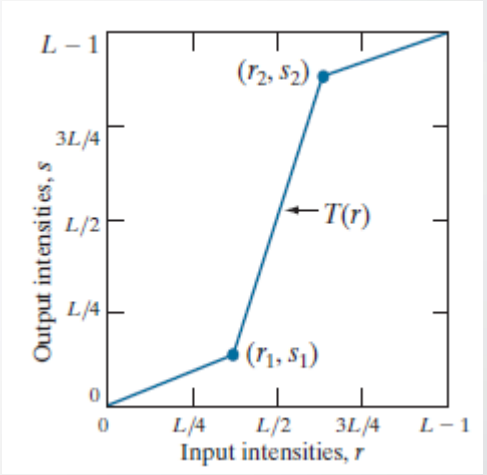
Log Transformations - Examples



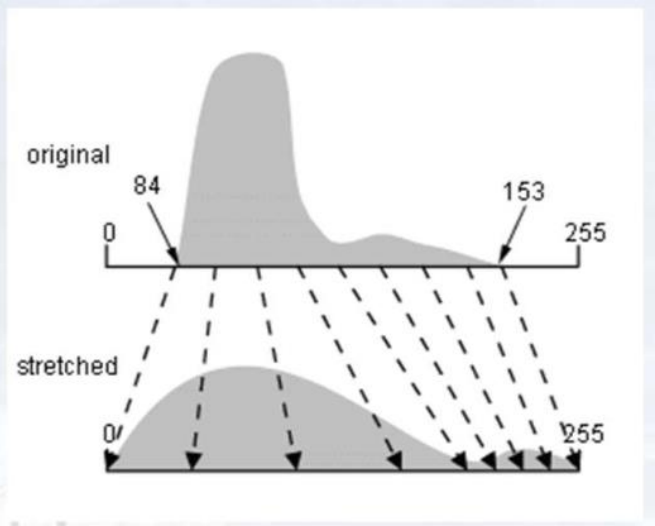
Piecewise Linear Transformation Functions

Contrast Stretching / Normalization

$$P_{out} = (P_{in} - c)\left(\frac{b-a}{d-c}\right) + a$$

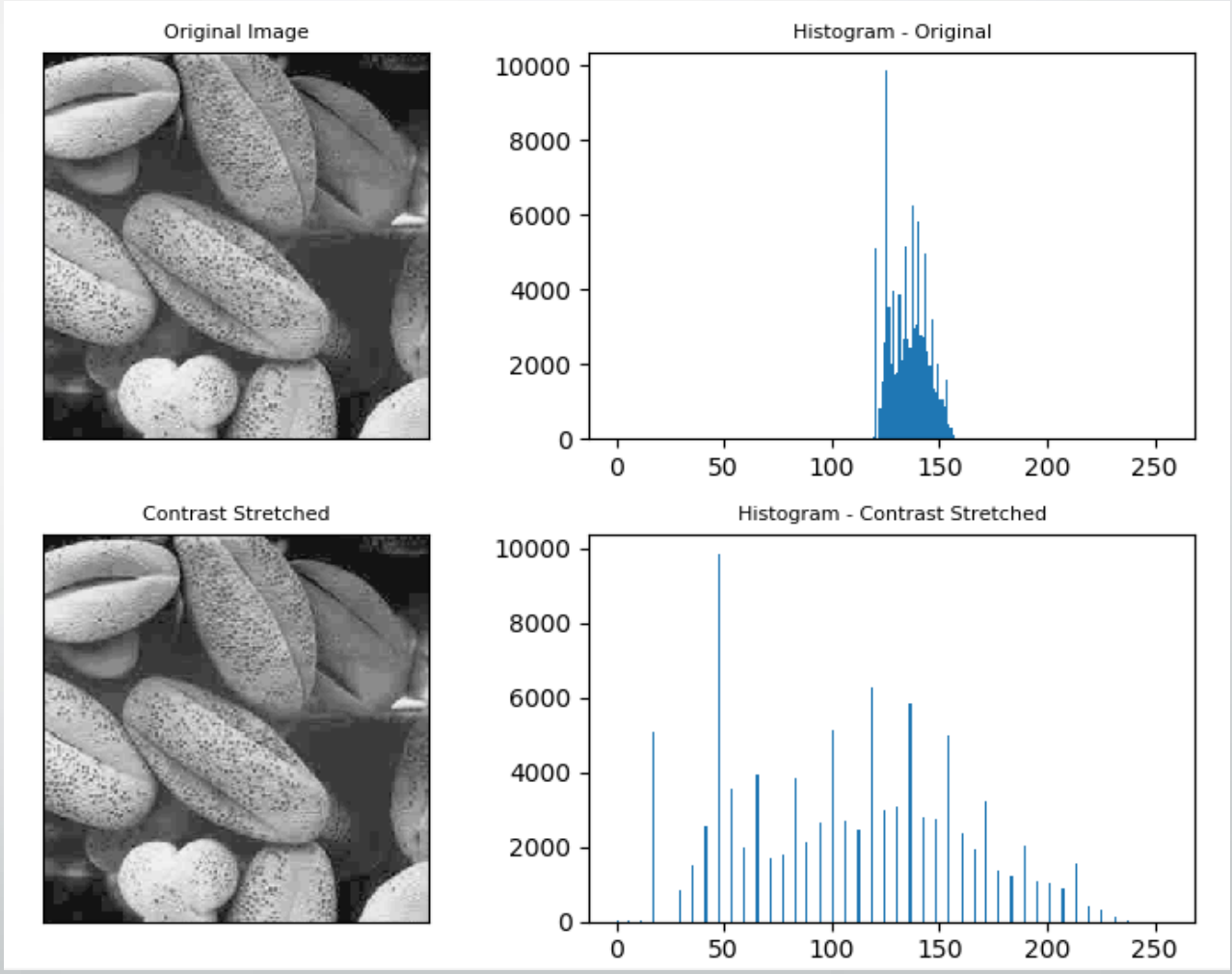


- P_{out} = new pixel value
- P_{in} = Input image Pixel Value
- a = lower limit for the data type
- b = upper limit for the data type
- c = min pixel value for the input image
- d = max pixel value for the input image



Contrast Stretching / Normalization

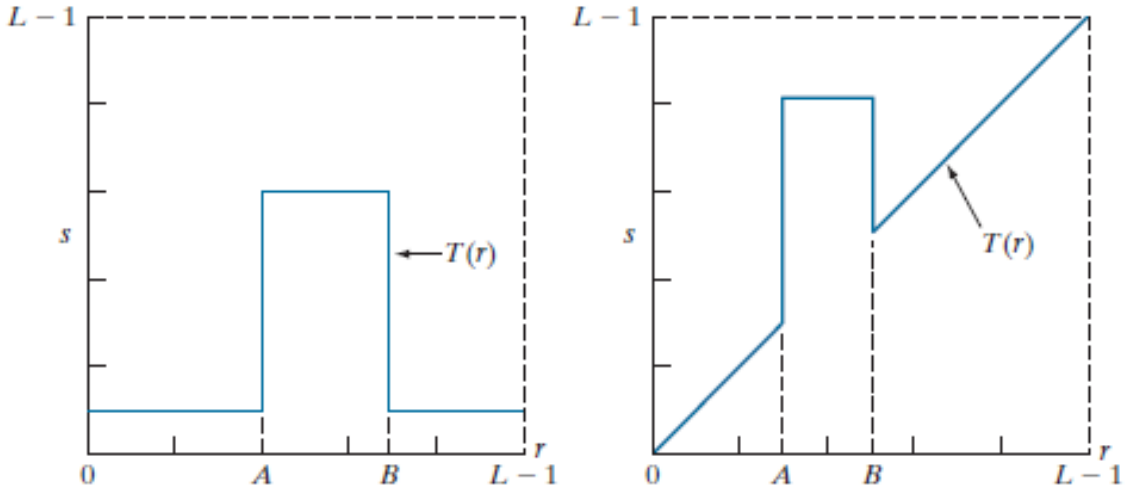
```
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread(r'images\contrast_str.png',
                 cv2.IMREAD_GRAYSCALE)

img__ = img.copy()

plt.figure()
plt.title("Original Grayscale Image Histogram")
plt.hist(img.ravel(),bins=256,range=[0,256])
plt.show()

input_max = np.max(img) #125
input_min = np.min(img)  #50

output_max = 255 # np.iinfo('uint8').max
output_min = 0 ## np.iinfo('uint8').min

out_img_ = (img-input_min) *(
              (output_max-output_min)/(
                  input_max-input_min))+output_min
out_img_ = np.array(out_img_, dtype = np.uint8)
```

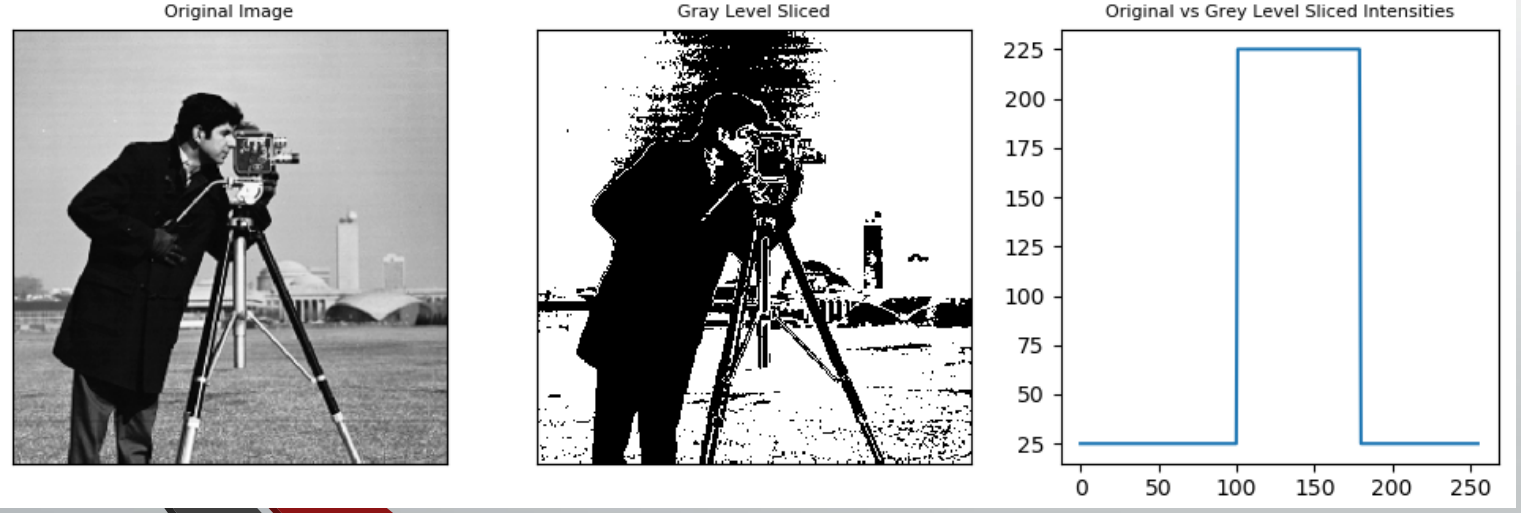


Gray-Level Slicing

a b

FIGURE 3.11
(a) This transformation function highlights range $[A, B]$ and reduces all other intensities to a lower level. (b) This function highlights range $[A, B]$ and leaves other intensities unchanged.



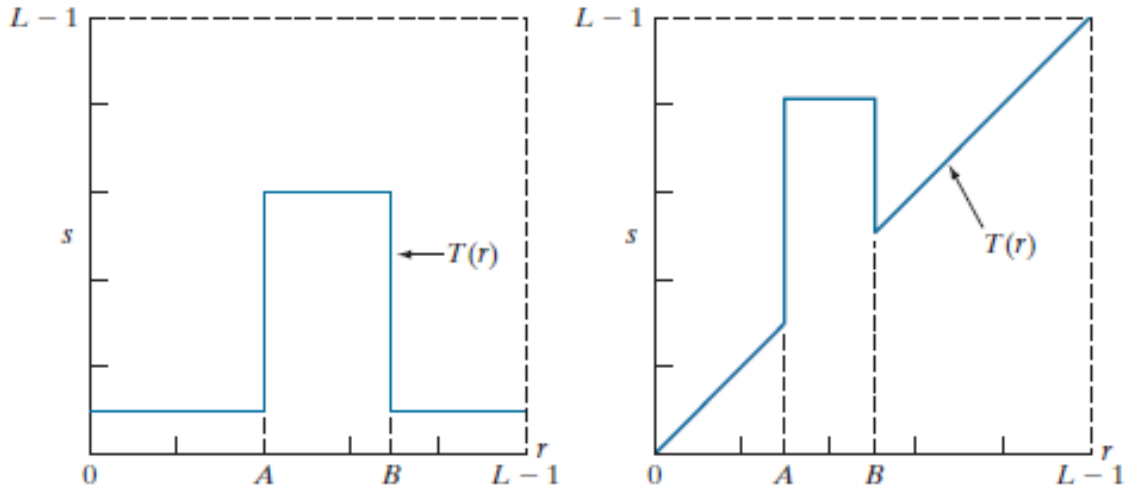


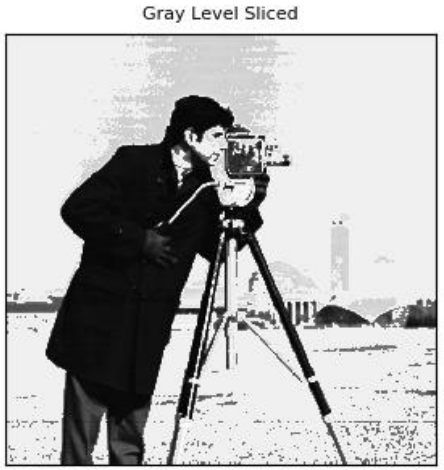

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread(r'images\cameraman.tif',
                 cv2.IMREAD_GRAYSCALE)
img_ = img.copy()

# the lower threshold value
T1 = 100

# the upper threshold value
T2 = 180

### create an array of zeros
img_new = np.zeros((img.shape[0],img.shape[1]),
                   dtype = 'uint8')

for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        #print(img[i,j])
        if T1 < img[i,j] and  img[i,j] < T2:
            img_new[i,j]= 225
        else:
            img_new[i,j]= 25 #img[i,j]

x = np.arange(0,256,1)
x1 = np.array(x)
print(x)

y3 = np.zeros_like(x1)
for i in range(0,len(x1)):
    if(x1[i]<T2 and x1[i]>T1 ):
        y3[i] = 225
    else:
        y3[i] = 25 #x1[i]
```

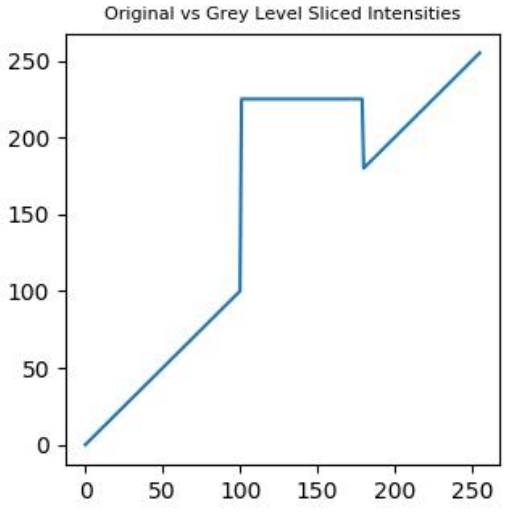
Gray-Level Slicing

a b

FIGURE 3.11
(a) This transformation function highlights range $[A, B]$ and reduces all other intensities to a lower level. (b) This function highlights range $[A, B]$ and leaves other intensities unchanged.








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

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                 cv2.IMREAD_GRAYSCALE)
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for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        #print(img[i,j])
        if T1 < img[i,j] and  img[i,j] < T2:
            img_new[i,j]= 225
        else:
            img_new[i,j]= img[i,j]

x = np.arange(0,256,1)
x1 = np.array(x)
print(x)

y3 = np.zeros_like(x1)
for i in range(0,len(x1)):
    if(x1[i]<T2 and x1[i]>T1 ):
        y3[i] = 225
    else:
        y3[i] = x1[i]
```

Bit Plane Slicing

https://theailearner.com/2019/01/25/bit-plane-slicing/

Thresholding

Thresholding / Binarization

The simplest form of segmenting images – background / foreground

Types of Thresholding

- Global Thresholding / Simple Thresholding
  Uses a global threshold value
- Adaptive Thresholding
  The algorithm will find a local threshold value for each area
  (better when considering images with inconsistent illumination)
- Otzu's Thresholding
  Optimized adaptive thresholding

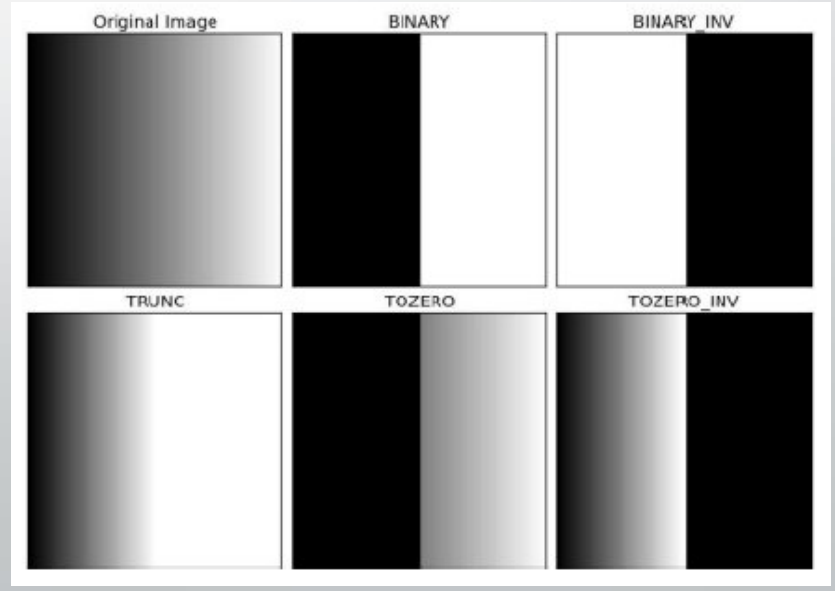
Global Thresholding

Syntax:

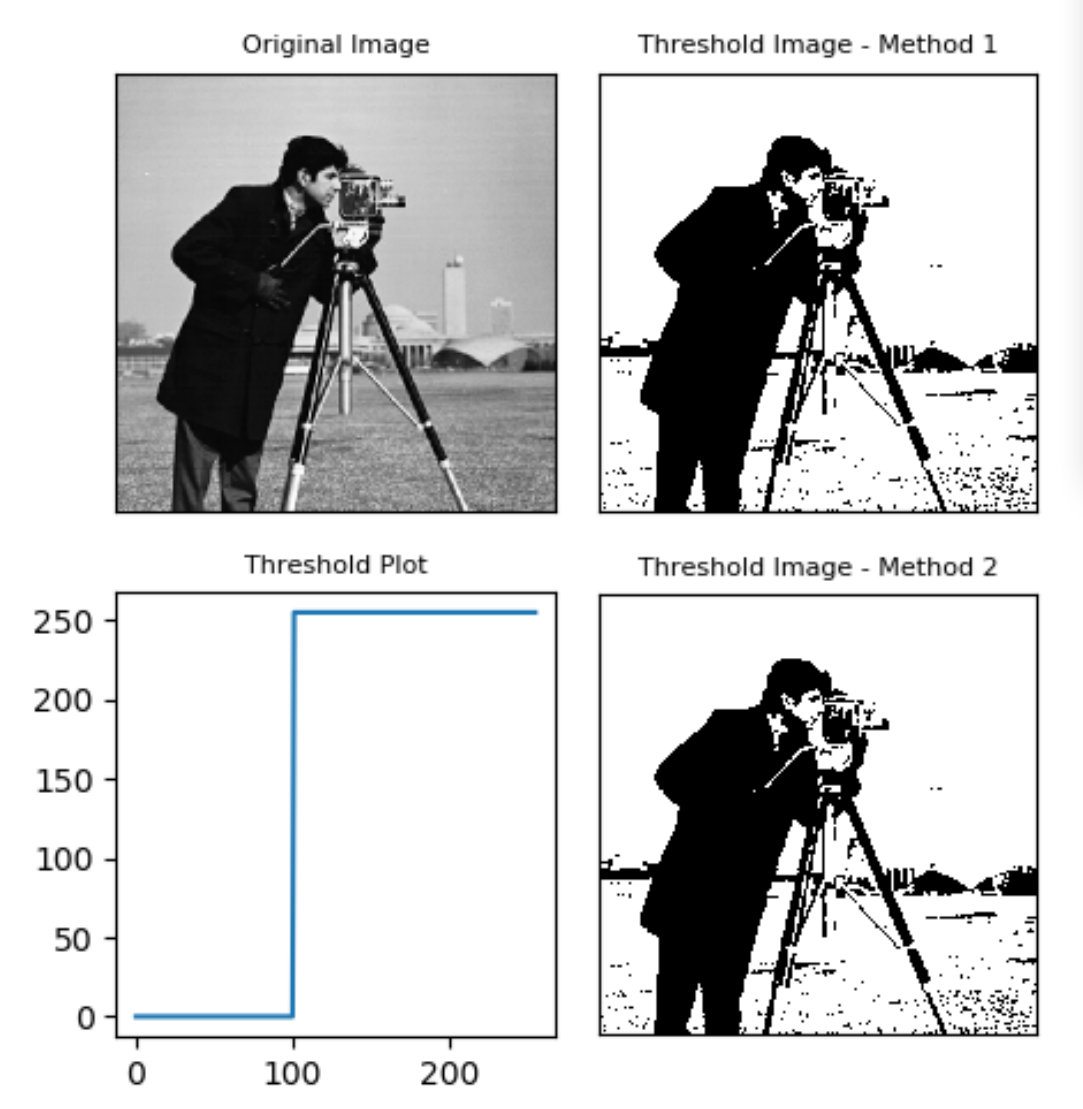
```
ret,thresh = cv2.threshold(img, thr_val, max_val, thresh_mode)
```

img : image array
thr_val : global threshold value
thresh_mode : is a flag which specifies the global threshold mode
max_val : maximum intensity value – 255 for ‘uint8’ images

- cv2.THRESH_BINARY
- cv2.THRESH_BINARY_INV
- cv2.THRESH_TRUNC
- cv2.THRESH_TOZERO
- cv2.THRESH_TOZERO_INV

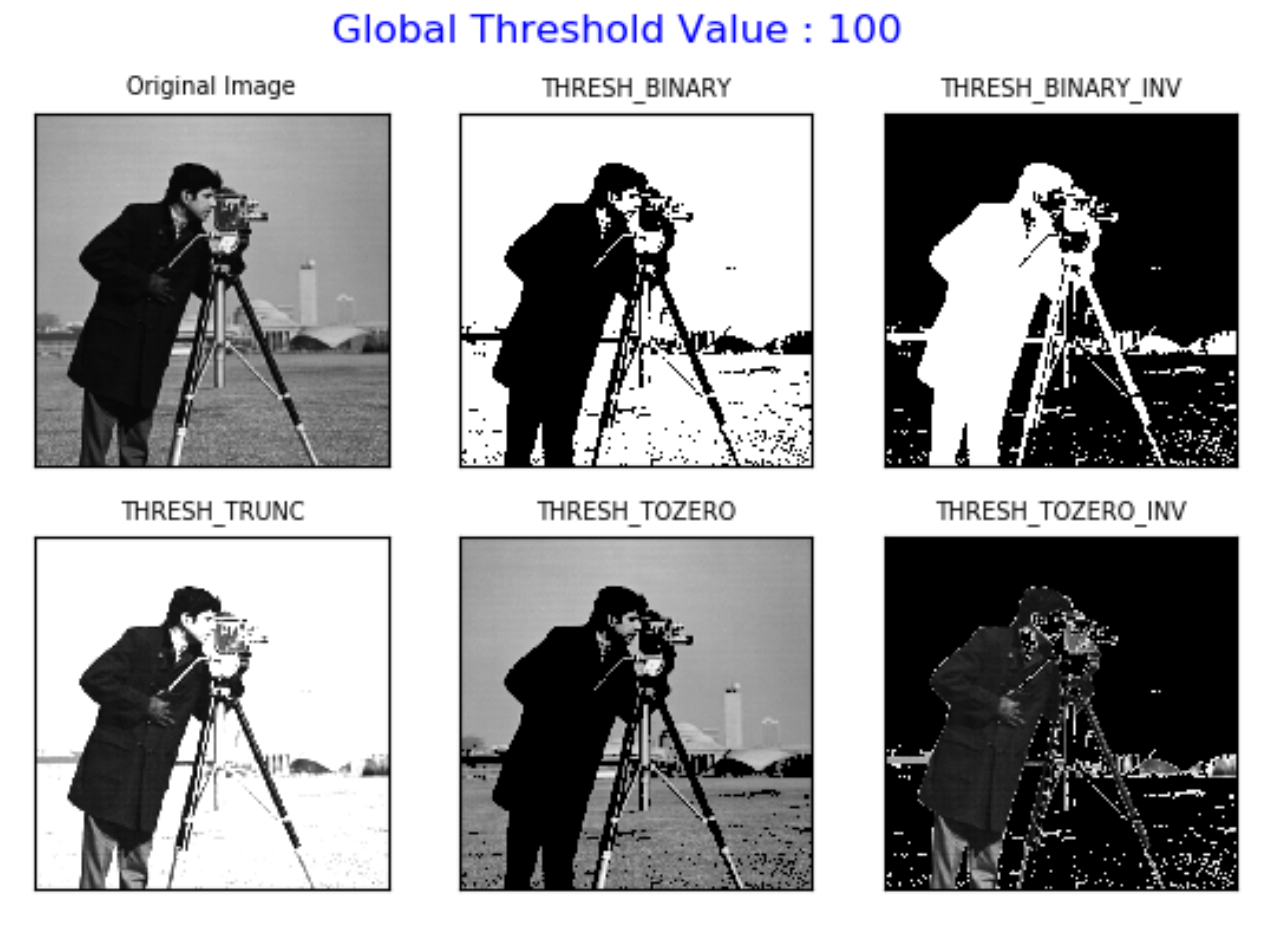


Global Thresholding




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

img = cv2.imread(r'images\cameraman.tif',
                 cv2.IMREAD_GRAYSCALE)
img_ = img.copy()

# global threshold value
T1 = 100

### create an array of zeros
img_new = np.zeros((img.shape[0],img.shape[1]),
                   dtype = 'uint8')

#method 1
img_[img<T1] = 0
img_[img>=T1] = 255

#method 2
for i in range(img.shape[0]):
    for j in range(img.shape[1]):
        #print(img[i,j])
        if img[i,j]<T1:
            img_new[i,j]= 0
        else:
            img_new[i,j]= 255

x = np.arange(0,256,1)
x1 = np.array(x)
print(x)

y3 = np.zeros_like(x1)
for i in range(0,len(x1)):
    if x1[i]>T1:
        y3[i] = 255
    else:
        y3[i] = 0
```

Global Thresholding




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

img = cv2.imread(r'images\cameraman.tif',cv2.IMREAD_GRAYSCALE)

# global threshold value
T1 = 100

ret,thresh1 = cv2.threshold(img,T1,255,cv2.THRESH_BINARY)
ret,thresh2 = cv2.threshold(img,T1,255,cv2.THRESH_BINARY_INV)
ret,thresh3 = cv2.threshold(img,T1,255,cv2.THRESH_TRUNC)
ret,thresh4 = cv2.threshold(img,T1,255,cv2.THRESH_TOZERO)
ret,thresh5 = cv2.threshold(img,T1,255,cv2.THRESH_TOZERO_INV)

titles = ['Original Image','THRESH_BINARY','THRESH_BINARY_INV',
          'THRESH_TRUNC','THRESH_TOZERO','THRESH_TOZERO_INV']
images = [img, thresh1, thresh2, thresh3, thresh4, thresh5]

plt.suptitle("Global Threshold Value : 100",color='blue')
for i in range(6):
    plt.subplot(2,3,i+1)
    plt.imshow(images[i],'gray')
    plt.title(titles[i],fontsize=7)
    plt.xticks([]),plt.yticks([])

plt.show()
```

Adaptive Thresholding

Syntax:

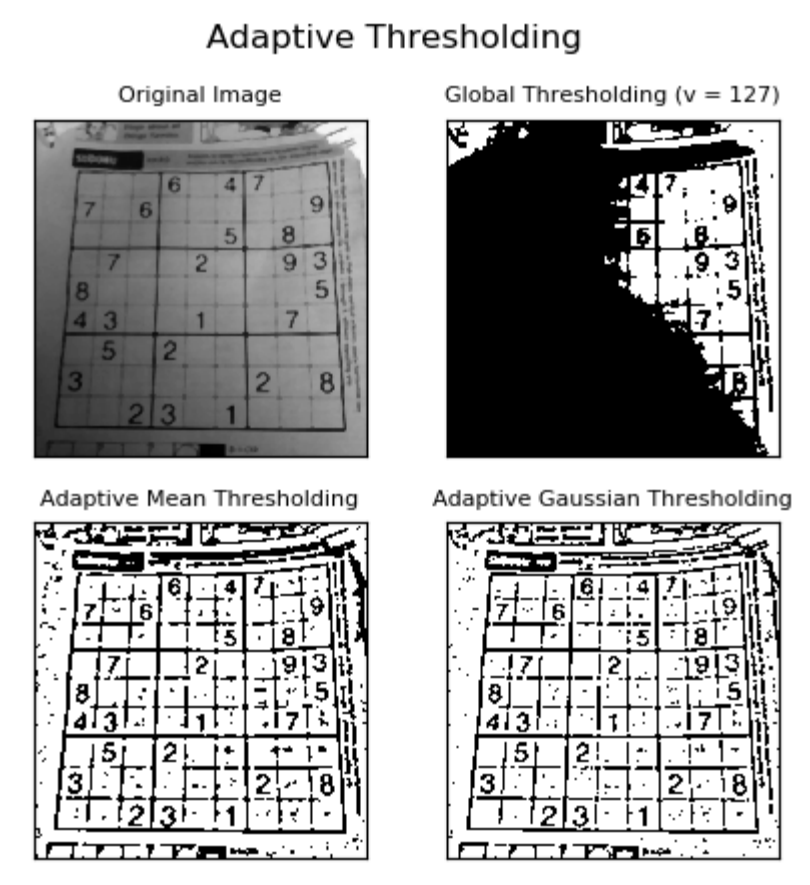
```
thr = cv2.adaptiveThreshold(img, max, adpt_m, thr_t, blk, C)
```

img : image array
max : maximum intensity value – 255 for ‘uint8’ images
thr_t : cv2 threshold type (**cv2.THRESH_BINARY | cv2.THRESH_BINARY_INV**)
blk : block size (size of the neighborhood area)
C : constant subtracted from mean or weighted sum of the neighborhood pixels
thr : threshold image
adpt_m : adaptive method

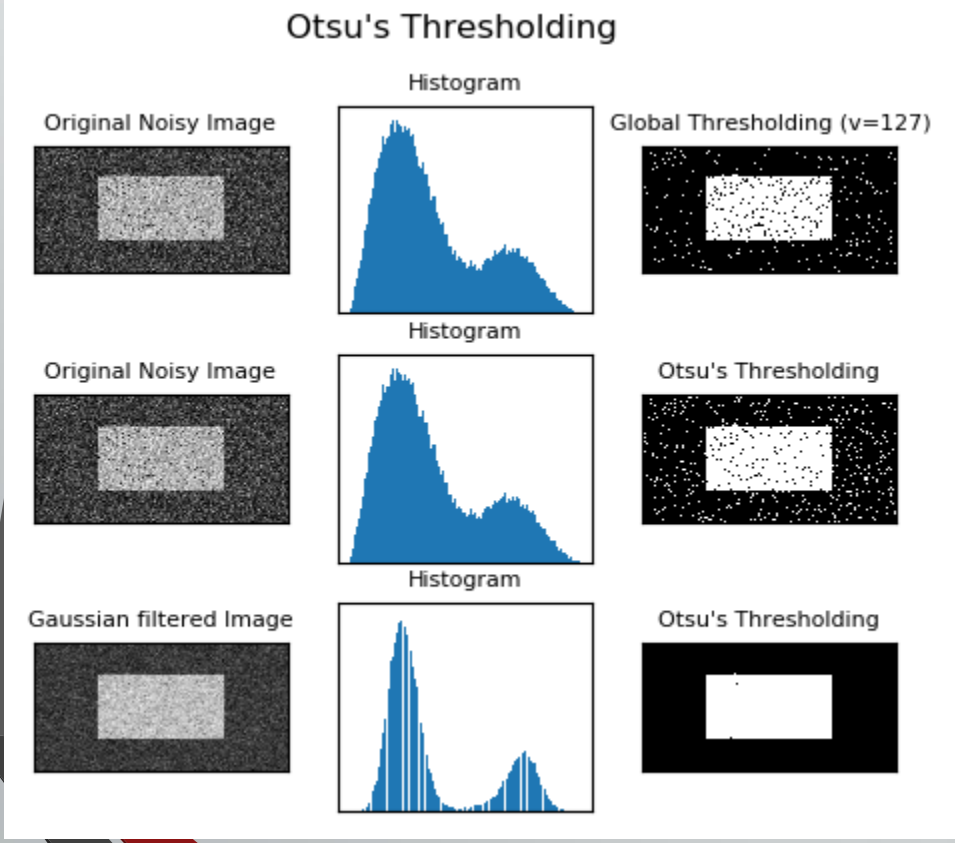
- **cv2.ADAPTIVE_THRESH_MEAN_C** : The threshold value is the mean of the neighborhood area minus the constant C.
- **cv2.ADAPTIVE_THRESH_GAUSSIAN_C**: The threshold value is a Gaussian-weighted sum of the neighborhood values minus the constant C

Adaptive Thresholding

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

img = cv2.imread(r'images\sudoku-original.jpg',cv2.IMREAD_GRAYSCALE)

img = cv2.medianBlur(img,5)
ret,th1 = cv2.threshold(img,127,255,cv2.THRESH_BINARY)

th2 = cv2.adaptiveThreshold(img,255,cv2.ADAPTIVE_THRESH_MEAN_C,\
            cv2.THRESH_BINARY,21,2)
th3 = cv2.adaptiveThreshold(img,255,cv2.ADAPTIVE_THRESH_GAUSSIAN_C,\
            cv2.THRESH_BINARY,21,2)

titles = ['Original Image', 'Global Thresholding (v = 127)',
            'Adaptive Mean Thresholding', 'Adaptive Gaussian Thresholding']

images = [img, th1, th2, th3]

plt.suptitle("Adaptive Thresholding")
for i in range(4):
    plt.subplot(2,2,i+1),plt.imshow(images[i],'gray')
    plt.title(titles[i],fontsize=8)
    plt.xticks([]),plt.yticks([])
plt.show()
```

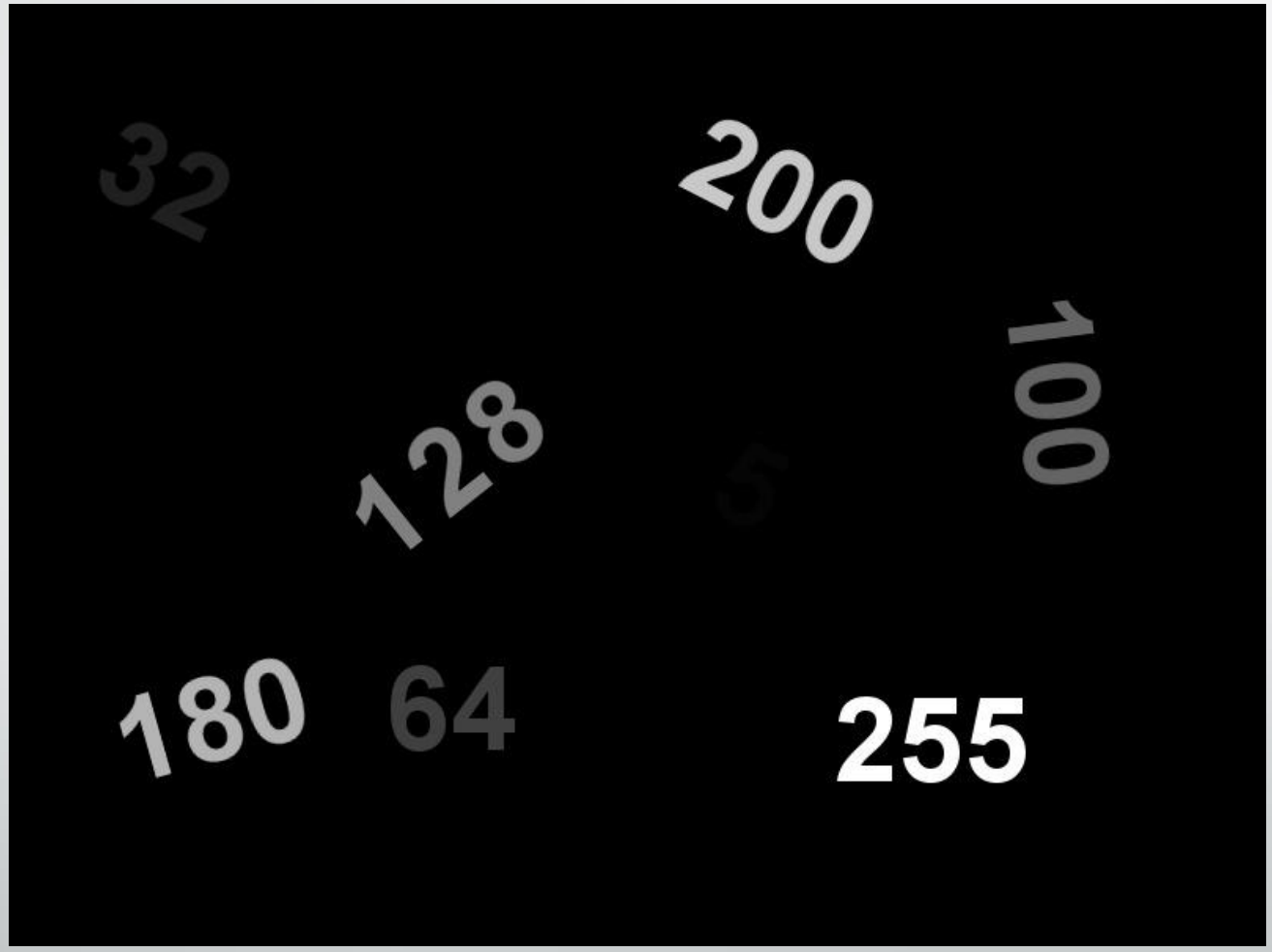


Otzu's Thresholding

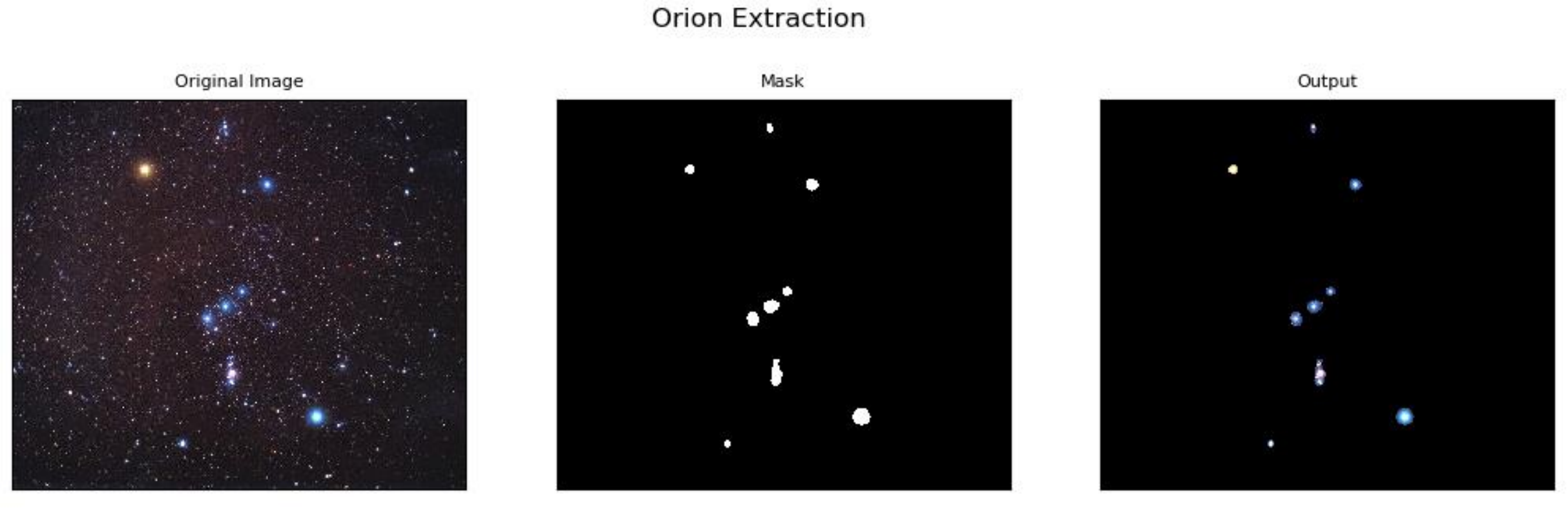



```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread(r'images\noisy2.png',cv2.IMREAD_GRAYSCALE)

# global thresholding
ret1,th1 = cv2.threshold(img,127,255,cv2.THRESH_BINARY)

# Otsu's thresholding
ret2,th2 = cv2.threshold(img,0,255,cv2.THRESH_BINARY+cv2.THRESH_OTSU)

# Otsu's thresholding after Gaussian filtering
blur = cv2.GaussianBlur(img,(5,5),0)
ret3,th3 = cv2.threshold(blur,0,255,cv2.THRESH_BINARY+cv2.THRESH_OTSU)

# plot all the images and their histograms
images = [img, 0, th1,
          img, 0, th2,
          blur, 0, th3]
titles = ['Original Noisy Image','Histogram','Global Thresholding (v=127)',
          'Original Noisy Image','Histogram',"Otsu's Thresholding",
          'Gaussian filtered Image','Histogram',"Otsu's Thresholding"]

plt.suptitle("Otsu's Thresholding")
for i in range(3):
    plt.subplot(3,3,i*3+1),plt.imshow(images[i*3],'gray')
    plt.title(titles[i*3],fontsize=8), plt.xticks([]), plt.yticks([])

    plt.subplot(3,3,i*3+2),plt.hist(images[i*3].ravel(),256)
    plt.title(titles[i*3+1],fontsize=8), plt.xticks([]), plt.yticks([])

    plt.subplot(3,3,i*3+3),plt.imshow(images[i*3+2],'gray')
    plt.title(titles[i*3+2],fontsize=8), plt.xticks([]), plt.yticks([])

plt.show()
```

Numbers Extraction



Orion Extraction



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