1-Thresholding

August 31, 2024

0.1 Thresholding

0.1.1 1. Simple thresholding:

- For every pixel, the same threshold value is applied. If the pixel value is smaller than the threshold, it is set to 0, otherwise it is set to a maximum value. The function cv.threshold is used to apply the thresholding.

0.1.2 2. Adaptive thresholding:

- In the simple thresholding, we used one global value as a threshold. But this might not be good in all cases, e.g. if an image has different lighting conditions in different areas.
- Adaptive thresholding algorithm determines the threshold for a pixel based on a small region around it. So we get different thresholds for different regions of the same image which gives better results for images with varying illumination.

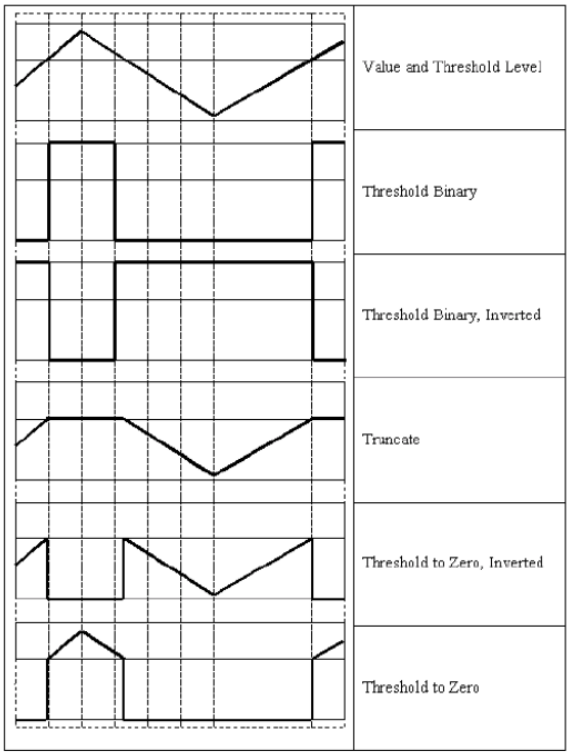
Reference: https://docs.opencv.org/4.x/d7/d4d/tutorial_py_thresholding.html

◆ ThresholdTypes

enum cv::ThresholdTypes

`#include <opencv2/imgproc.hpp>`

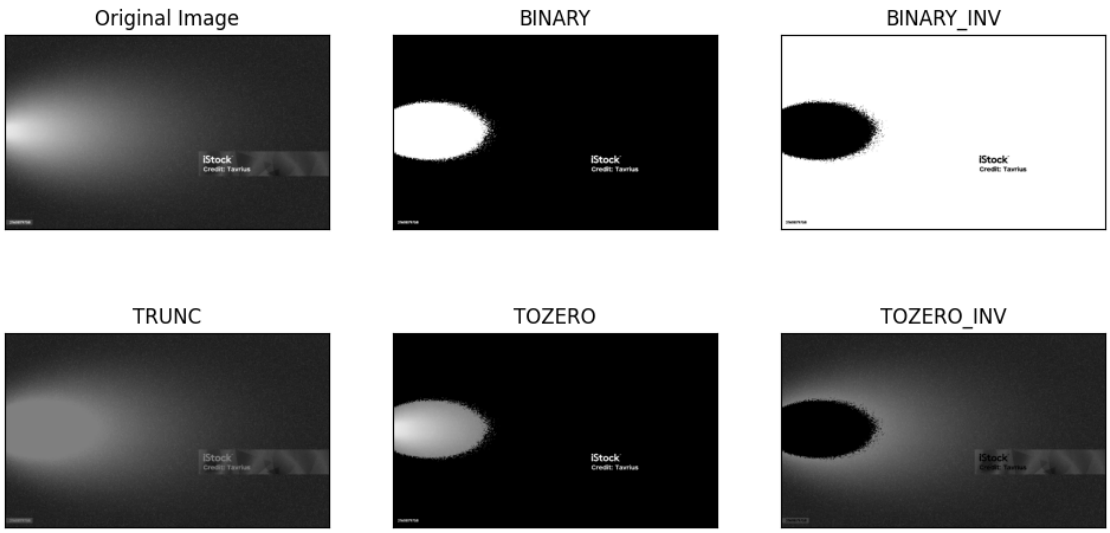
type of the threshold operation



Reference: https://docs.opencv.org/4.x/d7/d1b/group___imgproc___misc.html#ggaa9e58d2860d4afa658ef70a9b1

[ ]:
```python
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt

plt.figure(figsize=(12, 6))

# Input your image!
img = cv.imread('./assets/gradient.jpg', cv.IMREAD_GRAYSCALE)

threshold = 127
# print(img)
assert img is not None, "file could not be read, check with os.path.exists()"
ret,thresh1 = cv.threshold(img,threshold,255,cv.THRESH_BINARY)
ret,thresh2 = cv.threshold(img,threshold,255,cv.THRESH_BINARY_INV)
ret,thresh3 = cv.threshold(img,threshold,255,cv.THRESH_TRUNC)
ret,thresh4 = cv.threshold(img,threshold,255,cv.THRESH_TOZERO)
ret,thresh5 = cv.threshold(img,threshold,255,cv.THRESH_TOZERO_INV)
```

```
titles = ['Original Image','BINARY','BINARY_INV','TRUNC','TOZERO','TOZERO_INV']
images = [img, thresh1, thresh2, thresh3, thresh4, thresh5]

for i in range(6):
    plt.subplot(2,3,i+1),plt.imshow(images[i],'gray',vmin=0,vmax=255)
    plt.title(titles[i])
    plt.xticks([]),plt.yticks([])

plt.show()
```



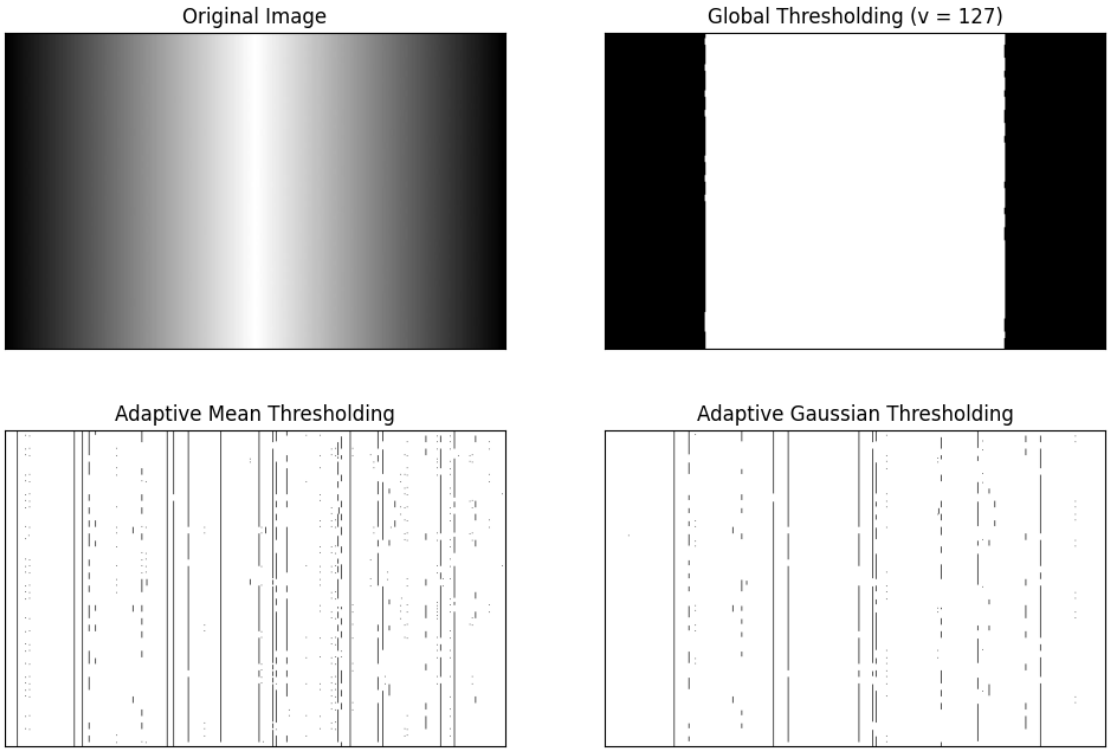
[ ]:
```
cv.adaptiveThreshold??
```

```
Docstring:
adaptiveThreshold(src, maxValue, adaptiveMethod, thresholdType, blockSize, C[,
dst]) -> dst
.   @brief Applies an adaptive threshold to an array.
.
.   The function transforms a grayscale image to a binary image according to the
formulae:
.   -   **THRESH_BINARY**
.       \f[dst(x,y) =  \fork{\texttt{maxValue}}{if \(src(x,y) >
T(x,y)\)}{0}{otherwise}\f]
.   -   **THRESH_BINARY_INV**
.       \f[dst(x,y) =  \fork{0}{if \(src(x,y) >
T(x,y)\)}{\texttt{maxValue}}{otherwise}\f]
.   where \f$T(x,y)\f$ is a threshold calculated individually for each pixel
(see adaptiveMethod parameter).
.
.   The function can process the image in-place.
```

```
.
.   @param src Source 8-bit single-channel image.
.   @param dst Destination image of the same size and the same type as src.
.   @param maxValue Non-zero value assigned to the pixels for which the
condition is satisfied
.   @param adaptiveMethod Adaptive thresholding algorithm to use, see
#AdaptiveThresholdTypes.
.   The #BORDER_REPLICATE | #BORDER_ISOLATED is used to process boundaries.
.   @param thresholdType Thresholding type that must be either #THRESH_BINARY or
#THRESH_BINARY_INV,
.   see #ThresholdTypes.
.   @param blockSize Size of a pixel neighborhood that is used to calculate a
threshold value for the
.   pixel: 3, 5, 7, and so on.
.   @param C Constant subtracted from the mean or weighted mean (see the details
below). Normally, it
.   is positive but may be zero or negative as well.
.
.   @sa  threshold, blur, GaussianBlur
Type:       builtin_function_or_method
```

[ ]:
```python
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt
plt.figure(figsize=(12, 8))
img = cv.imread('./assets/gradient_2.jpg', cv.IMREAD_GRAYSCALE)
assert img is not None, "file could not be read, check with os.path.exists()"
img = cv.medianBlur(img,5)

ret,th1 = cv.threshold(img,127,255,cv.THRESH_BINARY)

# blockSize: Size of a pixel neighborhood that is used to calculate a threshold␣
 ↪value for the pixel:11 here.
# C: Constant subtracted from the mean or weighted mean (2 in our case).␣
 ↪Normally, it is positive but may be zero or negative as well.

th2 = cv.adaptiveThreshold(img,255,cv.ADAPTIVE_THRESH_MEAN_C, cv.
 ↪THRESH_BINARY,3,1)
th3 = cv.adaptiveThreshold(img,255,cv.ADAPTIVE_THRESH_GAUSSIAN_C, cv.
 ↪THRESH_BINARY,3,1)

titles = ['Original Image', 'Global Thresholding (v = 127)',
            'Adaptive Mean Thresholding', 'Adaptive Gaussian Thresholding']
images = [img, th1, th2, th3]

for i in range(4):
    plt.subplot(2,2,i+1),plt.imshow(images[i],'gray')
```

```
    plt.title(titles[i])
    plt.xticks([]),plt.yticks([])
plt.show()
```



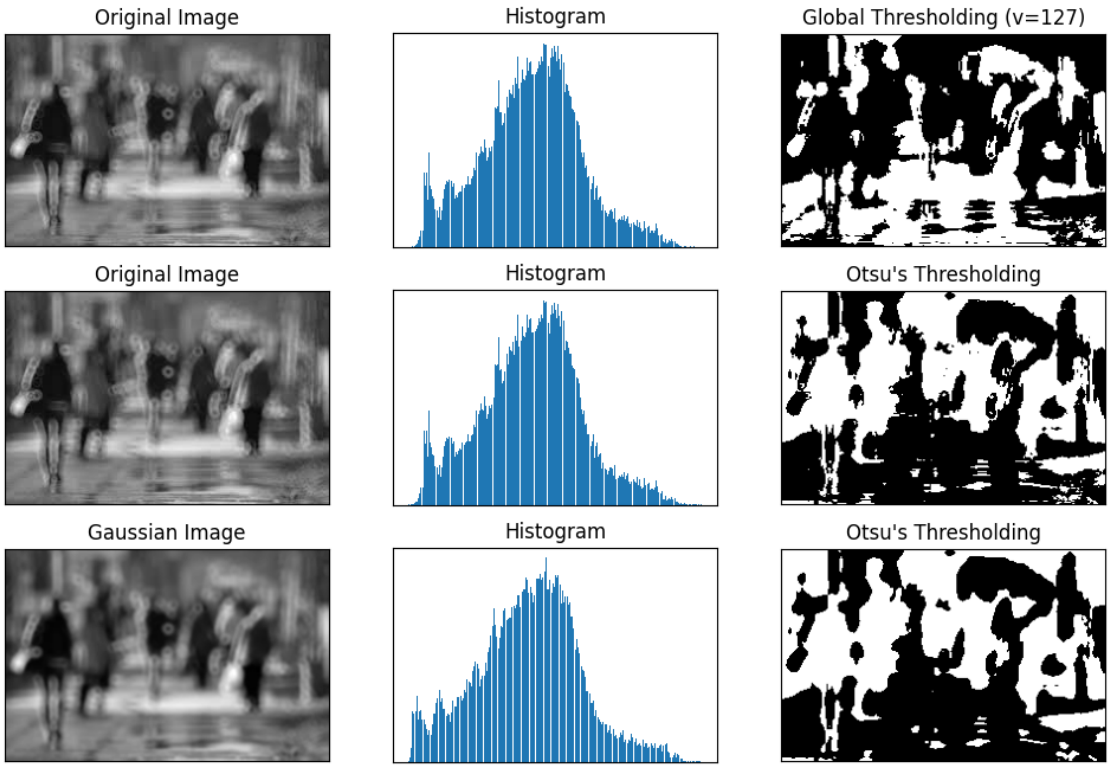
0.2 Otsu's Binarization

0.2.1 How it works??

https://docs.opencv.org/4.x/d7/d4d/tutorial_py_thresholding.html

[ ]:
```
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt
plt.figure(figsize=(12, 8))
img = cv.imread('./assets/blur.jpg', cv.IMREAD_GRAYSCALE)
assert img is not None, "file could not be read, check with os.path.exists()"

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

# Otsu's thresholding
ret2,th2 = cv.threshold(img,0,255,cv.THRESH_BINARY_INV+cv.THRESH_OTSU)
```

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

# plot all the images and their histograms
images = [img, 0, th1,
          img, 0, th2,
          blur, 0, th3]
titles = ['Original Image','Histogram','Global Thresholding (v=127)',
          'Original Image','Histogram',"Otsu's Thresholding",
          'Gaussian Image','Histogram',"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]), plt.xticks([]), plt.yticks([])
    plt.subplot(3,3,i*3+2),plt.hist(images[i*3].ravel(),256)
    plt.title(titles[i*3+1]), plt.xticks([]), plt.yticks([])
    plt.subplot(3,3,i*3+3),plt.imshow(images[i*3+2],'gray')
    plt.title(titles[i*3+2]), plt.xticks([]), plt.yticks([])
plt.show()
```

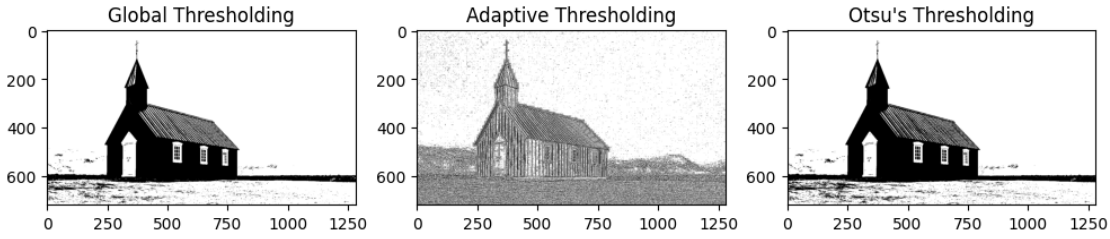


0.2.2 Task: (10 points)

1. Read an image and apply global, adaptive, and Otsu's thresholding.

2. Visualize the results.

[ ]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Step 1: Read the image in grayscale
img = cv2.imread('assets/church.jpg', cv2.IMREAD_GRAYSCALE)

# Step 2: Apply global thresholding
threshold = 127
ret1, thresh_global = cv2.threshold(img, threshold, 255, cv2.THRESH_BINARY)  #␣
 ↪Fill the missing values

# Step 3: Apply adaptive thresholding
thresh_adaptive = cv2.adaptiveThreshold(img, 255, cv2.
 ↪ADAPTIVE_THRESH_GAUSSIAN_C, cv2.THRESH_BINARY, 3, 1)

# Step 4: Apply Otsu's thresholding
ret2, thresh_otsu = cv2.threshold(img, 0, 255, cv2.THRESH_BINARY + cv2.
 ↪THRESH_OTSU)

# Step 5: Visualize the images
plt.figure(figsize=(12, 6))
plt.subplot(131), plt.imshow(thresh_global, cmap='gray'), plt.title('Global␣
 ↪Thresholding')
plt.subplot(132), plt.imshow(thresh_adaptive, cmap='gray'), plt.title('Adaptive␣
 ↪Thresholding')
plt.subplot(133), plt.imshow(thresh_otsu, cmap='gray'), plt.title('Otsu\'s␣
 ↪Thresholding')
plt.show()
```



[ ]: