IMAGE BINARIZATION

gImage Processin

مقدمه

تعریف

Image binarization با زبان ساده همان سیاه ، سفید کردن عکس است. در واقع هر پیکس ماکزیمم یا مینیمم مقدار ممکن را میگیرد

کاربرد

- جداسازی پس زیمنه از محتوا
- بدست آوردن اطلاعات از بخش های مختلف عکس

ساز و کار

نوع عکس

معمولا بر روی عکس های خاکستری انجام می گیرد.(عکس های رنگی تبدیل به حاکستری می شوند)

منطق تبدیل

هر پیکسل با مقداری به نام threshold مقایسه شده

- Pixel > threshold => pixel = 255
- Else => pixel = 0

دسته بندی

Global

در این روش یک مقدار کلی threshold برای تمامی پیکسل های عکس اعمال می شود

Local

در این روش عکس به پنجره های مختلفی شکسته شده و برای هر پنجره یک مقدار threshold پیدا شده و برای همان پنجره اعمال می شود.

الگوریتم های مورد بررسی

- Constant T
- Global iterative
- Adaptive or local iterative
- Niblack
- Global OTSU

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ترم

بهار 1401

Image threshold module

یک ماژول نوشته شده توسط شخص خود برای راختی کار و همچنین clean code بودن است که شامل توابعی است :

- getWindow(img, x, y, w ,h) : این تابع عکسی را می گیرد و با توجه به مختصات x,y و طول پنجره w,h پیکسل های آن پنجره را به ما بر می گرداند. یکی از فواید آن این است اگر به آخر عکس رسیده باشیم و طول یا عرض یا هر دو پنجره از عکس بیرون بزند ، خود تابع متوجه شده و مقدار را تنظیم می کند.
- setWindow(img, x, y, window) : این تابع پنجره ای را میگیرد و با توجه به مختصات داده شده آن را در عکس جایگزین می کند.
- applyT(img , t) : این تابع یک عکس را می گیرد و t را که threshold است برای تمام پیکسل ها اعمال می کند.
- aapplyTInWindow(window, t) : این تابع یک پنجره را می گیرد و t را که threshold است برای تمام پیکسل ها ی آن پنجره اعمال می کند.
- lightOccurances(window) : این تابع یک پنجره را میگیرد و لیستی از فراوانی پیکسل های آن پنجره بر می گیرداند.(در gray-scale از 0 تا 255 است)
- histogram(data , count) : این تابع هیستوگرام را حساب می کند.
- findT(hist, T = 128) : این تابع هیستوگرام و یک threshold اولیه را میگیرد و threshold را محاسبه می کند. (برای روش های global iterative و local iterative به کار می رود)
- meanOfWindow(window) : میانگین پیکسل های پنجره را می دهد.
- stdOfWindow(window, avg) : انحراف معیار پنجره را بر می گرداند.

CONSTANT T

- در این روش به طور مثال threshold را مقدار 55 در نظر گرفته و کل پیکسل ها اعمال می کنیم.

کد :

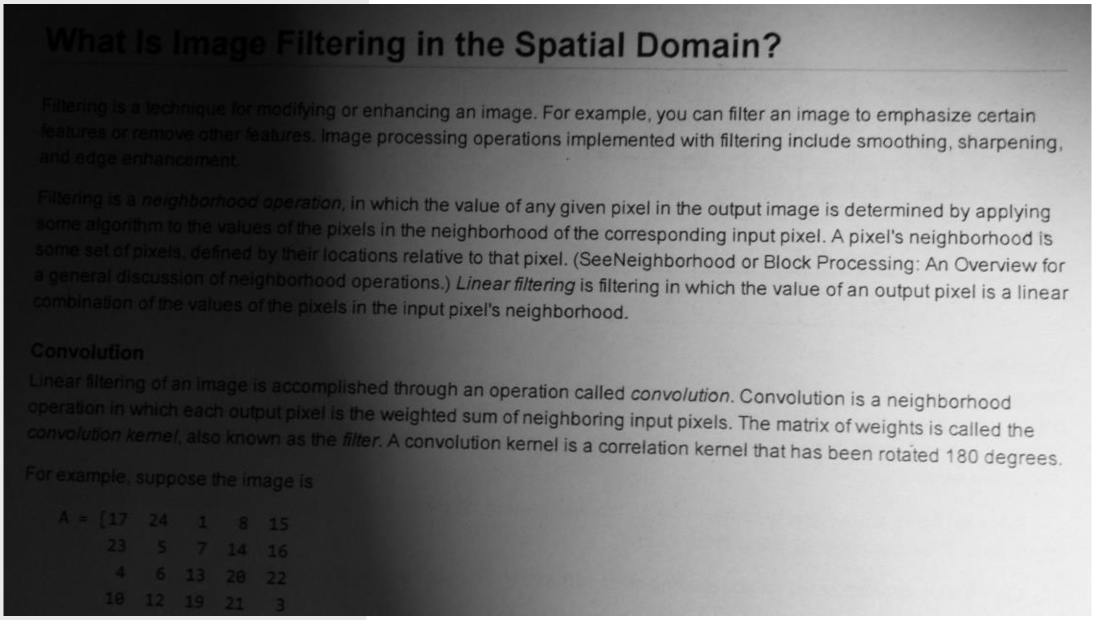
```
from ImageThreshold import *

def applyConstantT(src,t = 55):
    img = Image.open(src).convert('L')
    return applyT(img,t)

if __name__ == "__main__":

applyConstantT('image1.png').save('image1_constant_t_128.png')
```

عکس اولیه :



What Is Image Filtering in the Spatial Domain?

Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement.

Filtering is a *neighborhood operation*, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel. (SeeNeighborhood or Block Processing: An Overview for a general discussion of neighborhood operations.) *Linear filtering* is filtering in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighborhood.

Convolution

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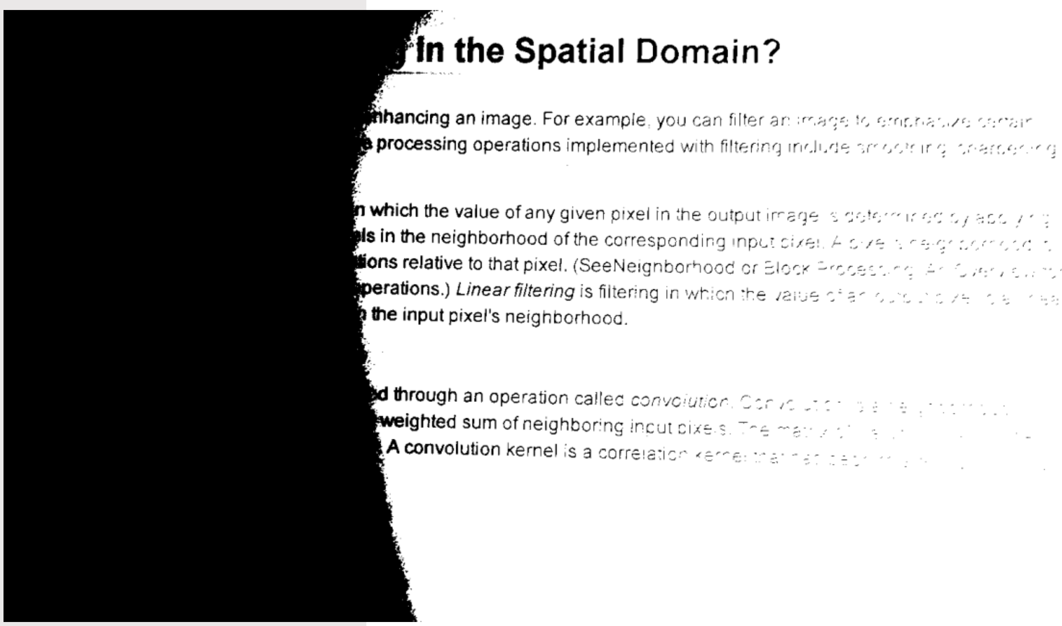

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GLOBAL ITERATIVE

- در این روش به هیستوگرام تمام پیکسل ها محاسبه می شود.
- سپس داده ها را بر اساس مقدار اولیه t، جدا کرده و میانگین مجموع دو طرف را محاسبه کرده تا t2، بدست آید . حال اگر قدر مطلق تفاوت در t ها آن قدر کم بود (مانند 0.0000001) ، t بدست می آید در غیر این صورت این روند را برای هر t جدید تکرار کرده.

کد :

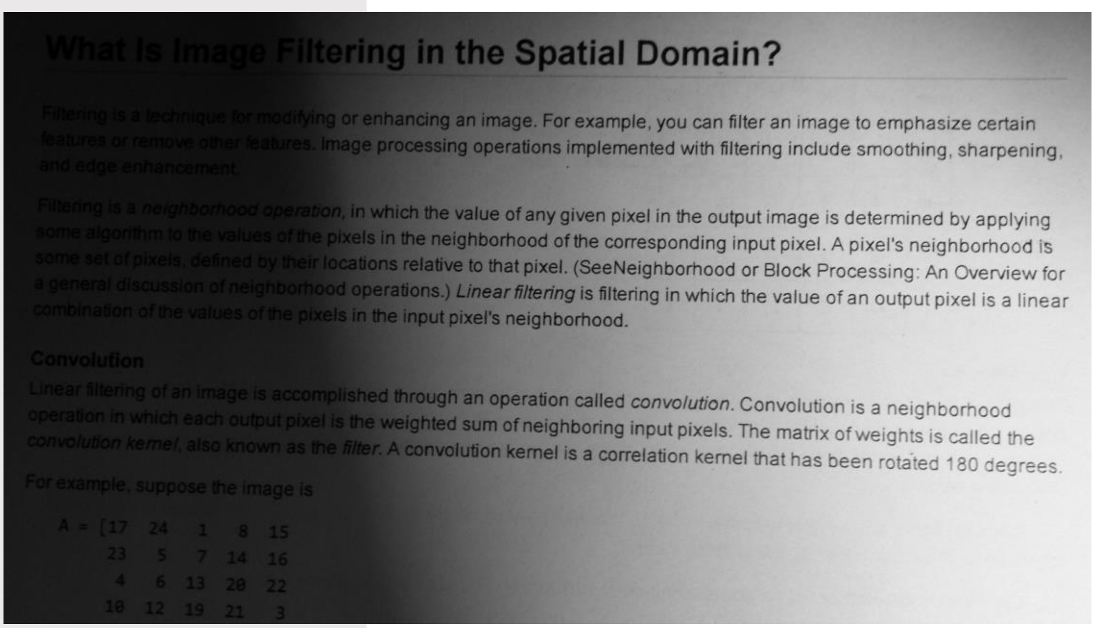
```python
from ImageThreshold import *

def applyGlobalIterative(src):
    img = Image.open(src).convert('L')
    width, height = img.size
    window = getWindow(img,0,0,width,height)
    lights = lightOccurances(window)
    hist = histogram(lights,width * height)
    t = findT(hist)
    print('t:',t)
    return applyT(img,t)


if __name__ == "__main__":

applyGlobalIterative('image1.png').save('image1_globa
l_iterative.png')
```

عکس اولیه :



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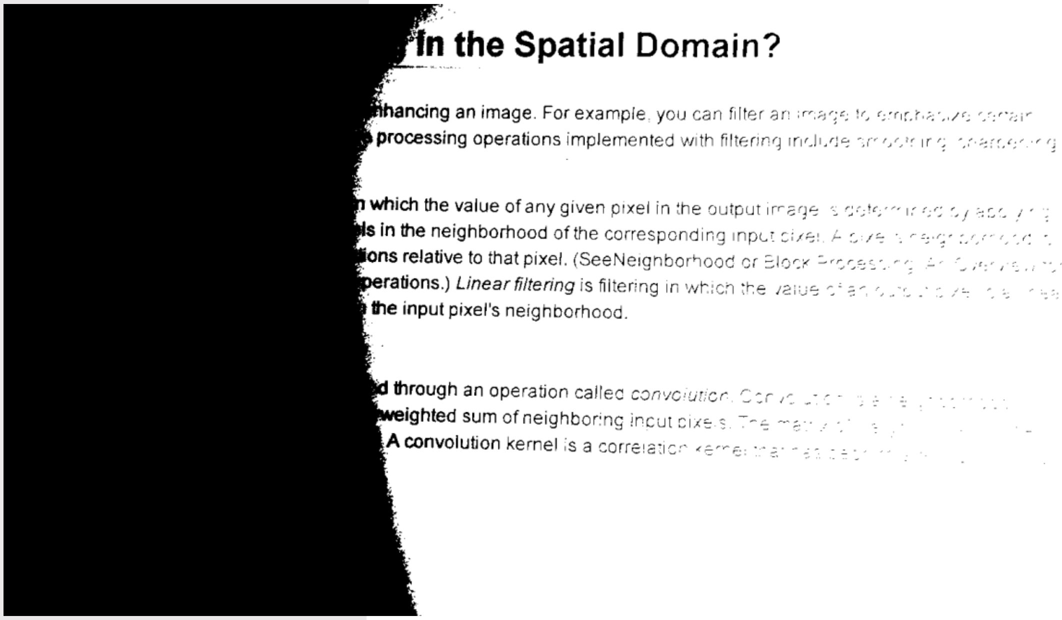


T بدست آمده برابر با 56 است در این روش.

LOCAL ITERATIVE

- این روش مانند روشش قبل است تنها تمام عملیات ها فقط برای هر پنجره تکرار می شوند.

کد :

```
from ImageThreshold import *

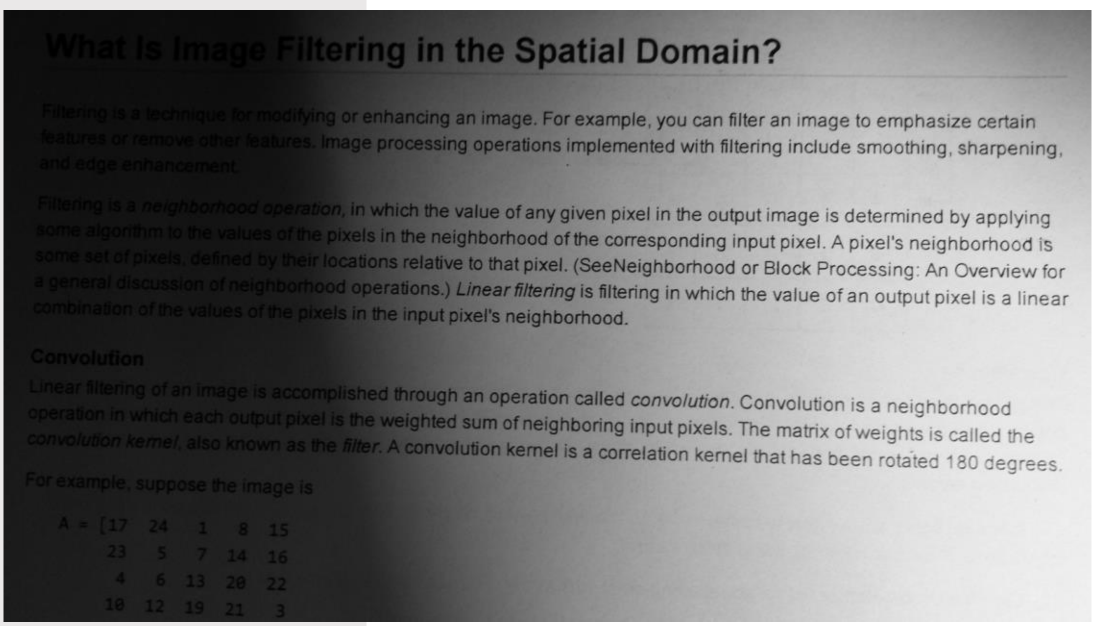
def applyLocalIterative(src, windowX, windowY):
    img = Image.open(src).convert('L').copy()
    width, height = img.size

    for i in range(0,width,windowX):
        for j in range(0,height,windowY):
            window = getWindow(img, i, j, windowX, windowY)
            lights = lightOccurances(window)
            hist = histogram(lights, windowX * windowY)
            t = findT(hist)
            setWindow(img,i,j, applyTInWindow(window,t) )

    return img

if __name__ == "__main__":
    applyLocalIterative('image1.png', 25,
25).save('image1_local_iterative.png')
```

عکس اولیه :



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NIBLACK

- در این روش انحراف معیار و میانگین هر پنجره محاسبه می شود سپس Thresholdبه صورت mean – k*std محاسبه شده.در واقع std بالاتر به معنای غیر یکنواختی بیشتر به معنای اطلاعات بیشتر است.
- طبق تجربه در این روش پنجره 15*15 و k=-0.2 نتایج بهتری دارد.

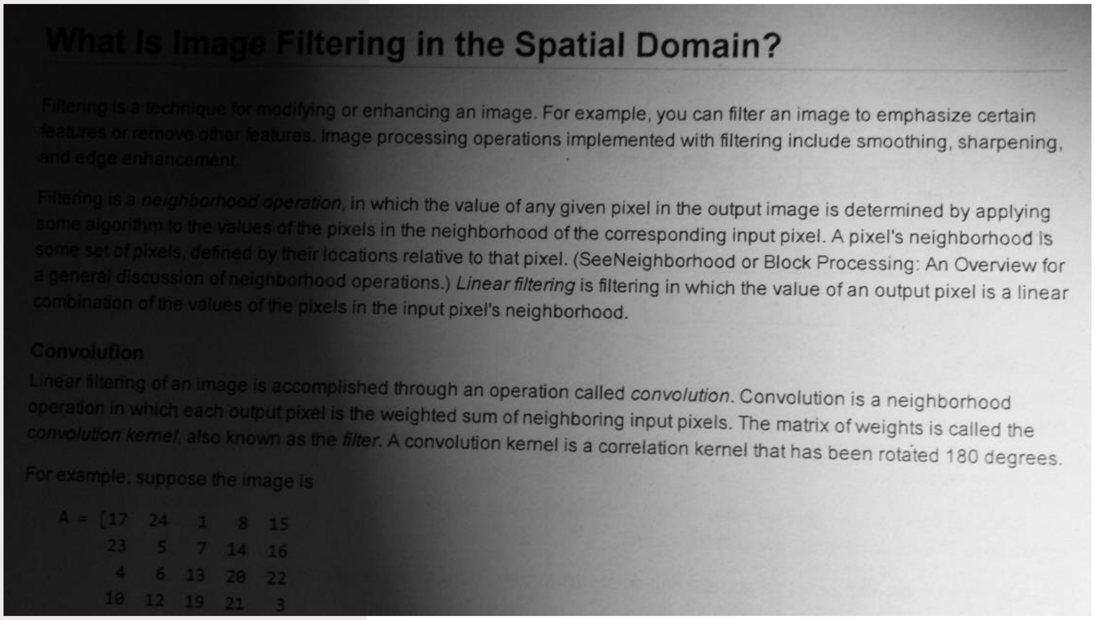
کد :

```
from ImageThreshold import *


def applyNiblack(src,k, windowX, windowY):
    img = Image.open(src).convert('L').copy()
    width, height = img.size
    for i in range(0,width,windowX):
        print(i)
        for j in range(0,height,windowY):
            window = getWindow(img, i, j, windowX, windowY)
            mean = meanOfWindow(window)
            std = stdOfWindow(window,mean)
            t = int(numpy.round(mean + (k * std)))
            window = applyTInWindow(window, t)
            setWindow(img, i, j, window)
    return img

if __name__ == "__main__":
    applyNiblack('image1.png',-0.2, 25,
25).save('image1_niblack.png')
```

عکس اولیه :



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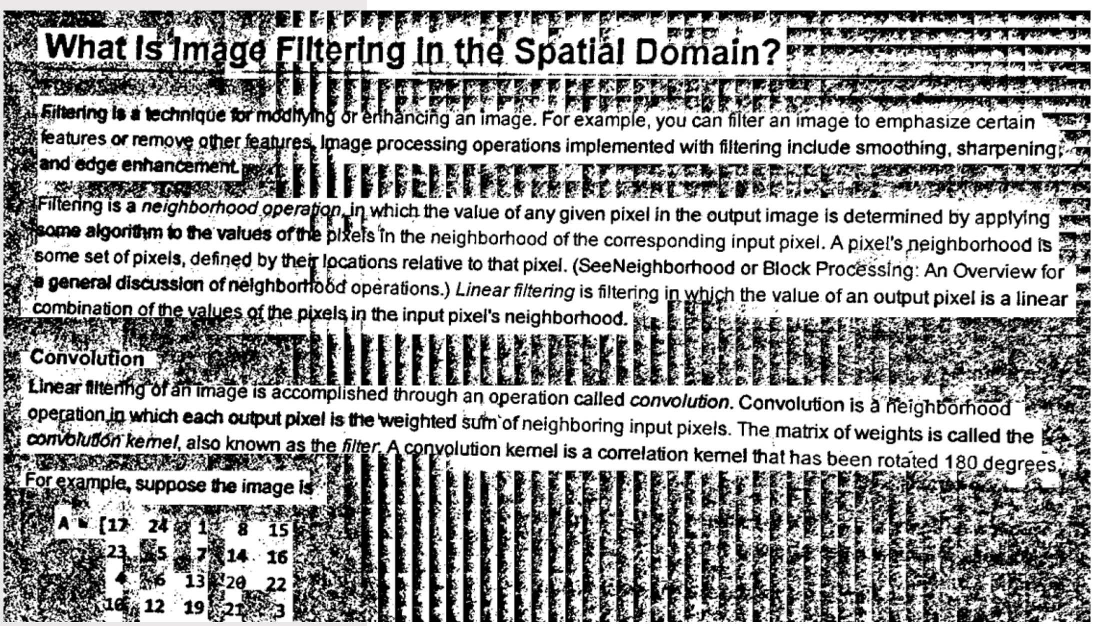

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- این روش بر اساس واریانس است. کلید اصلی پیدا کردن threshold این است که وزن واریانس بین پس زمینه و محتوا را مینیمم کرد.

$$\sigma_1^2(t) = \sum_{i=1}^{t} [i - \mu_1(t)]^2 \frac{P(i)}{w_1(t)} \text{ and } \sigma_2^2(t) = \sum_{i=t+1}^{I} [i - \mu_2(t)]^2 \frac{P(i)}{w_2(t)}$$

کد :

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def applyLocalIterative(src):
    img = Image.open(src).convert('L').copy()
    width, height = img.size
    window = getWindow(img, 0, 0, width, height)
    lightOccurances = [0 for i in range(256)]

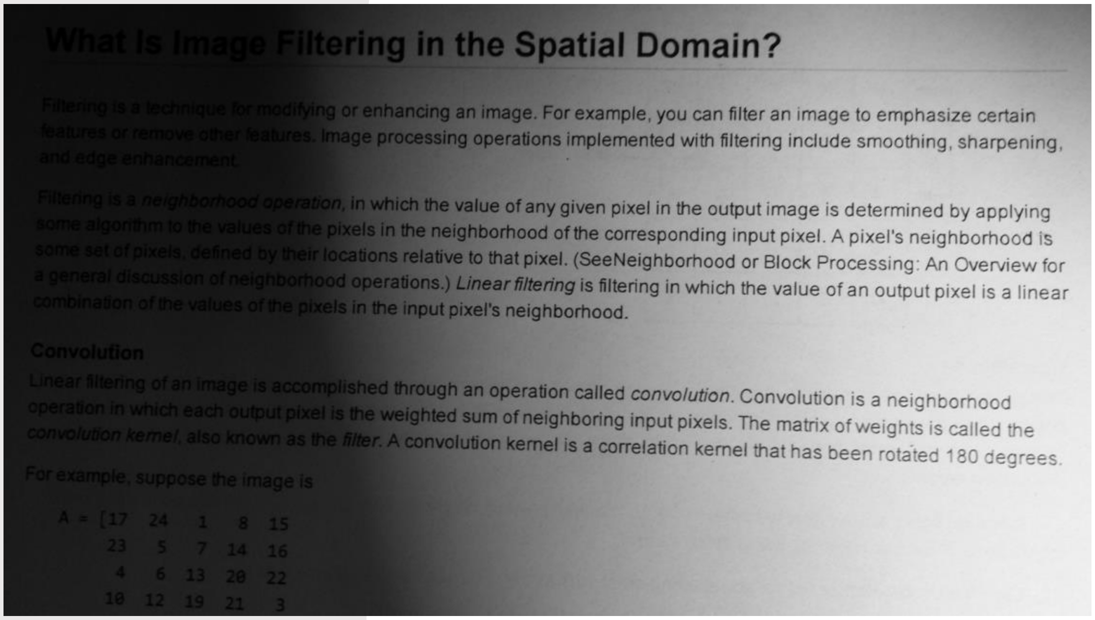
    for light in range(256):
        beforeLight = []
        afterLight = []
        print(light)
        for i in range(width):
            for j in range(height):
                pixel = window['window'][i][j]
                if light <= pixel:
                    afterLight.append(pixel)
                else:
                    beforeLight.append(pixel)
        meanBefore = sum(beforeLight) / len(beforeLight) if len(beforeLight) else 0
        meanAfter = sum(afterLight) / len(afterLight) if len(afterLight) else 0
        lightOccurances[light] = len(beforeLight) * len(afterLight) * (meanBefore - 
meanAfter) ** 2

    t = 0
    for i in range(len(lightOccurances)):
        if lightOccurances[t] < lightOccurances[i]:
            t = i
    print(t)

    return applyT(img, t)


if __name__ == "__main__":
    applyLocalIterative('image1.png').save('image1_otsu.png')
```

عکس اولیه :



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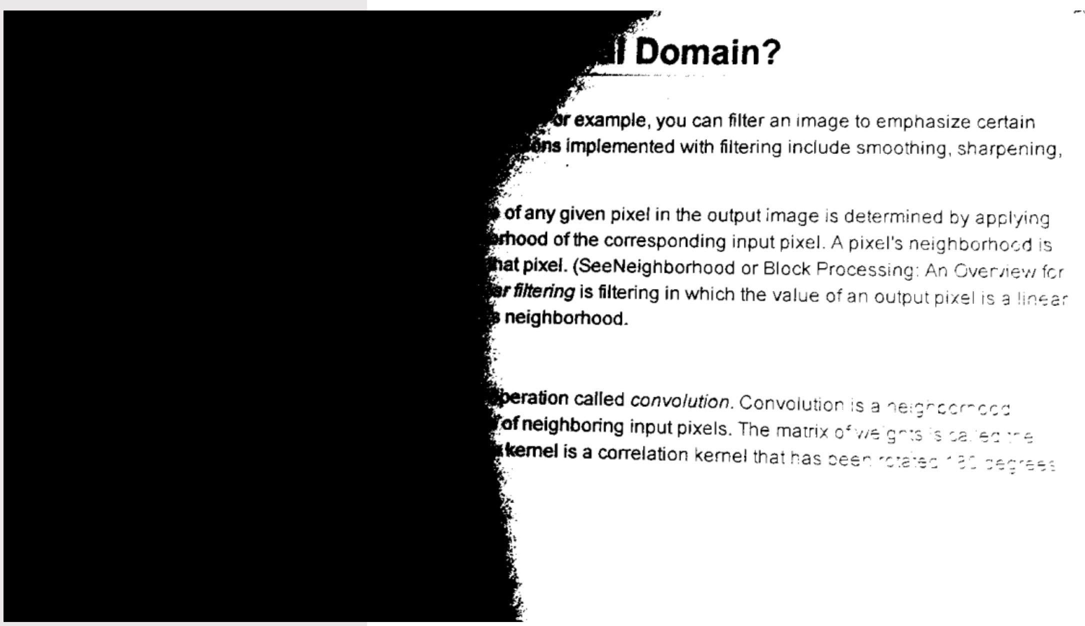

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نتیجه گیری

#	مزایا	معایب	اساس
Constant	سرعت بالا	Threshold کلی عکس را به دو بخش اعمال می کند و چون global است به خوبی تمایز هارا نشان نمی دهد	انتخاب یک T و اعمال آن به کل تصویر
Global	نسبت به Constant T خوبی آن این است که T را خودش پیدا می کند .	Threshold کلی عکس را به دو بخش اعمال می کند و چون global است به خوبی تمایز هارا نشان نمی دهد	پیدا کردن هیستوگرام سپس پیدا کردن T optimal
Local	به خاطر محلی بودن و optimal بودن T بین پس زمینه و محتوا خوب تفاوت ایجاد می شود.	سرعت پایین به خاطر پنجره های زیاد و ممکن است بخشی از اطلاعات کم رنگ شود.	پیدا کردن هیستوگرام سپس پیدا کردن T optimal برای هر پنجره
Niblack	مناسب برای تشخیص متن	پس زمینه مانند local آن قدر یکدست مجزا نمی شود	غیر یکنواختی بر اساس میانگین و انحراف معیار محلی هر پنجره
OTSU	-	در نویز بالا و شی های کوچک خوب عمل نمی کند	واریانس