计算机视觉

彭盛霖

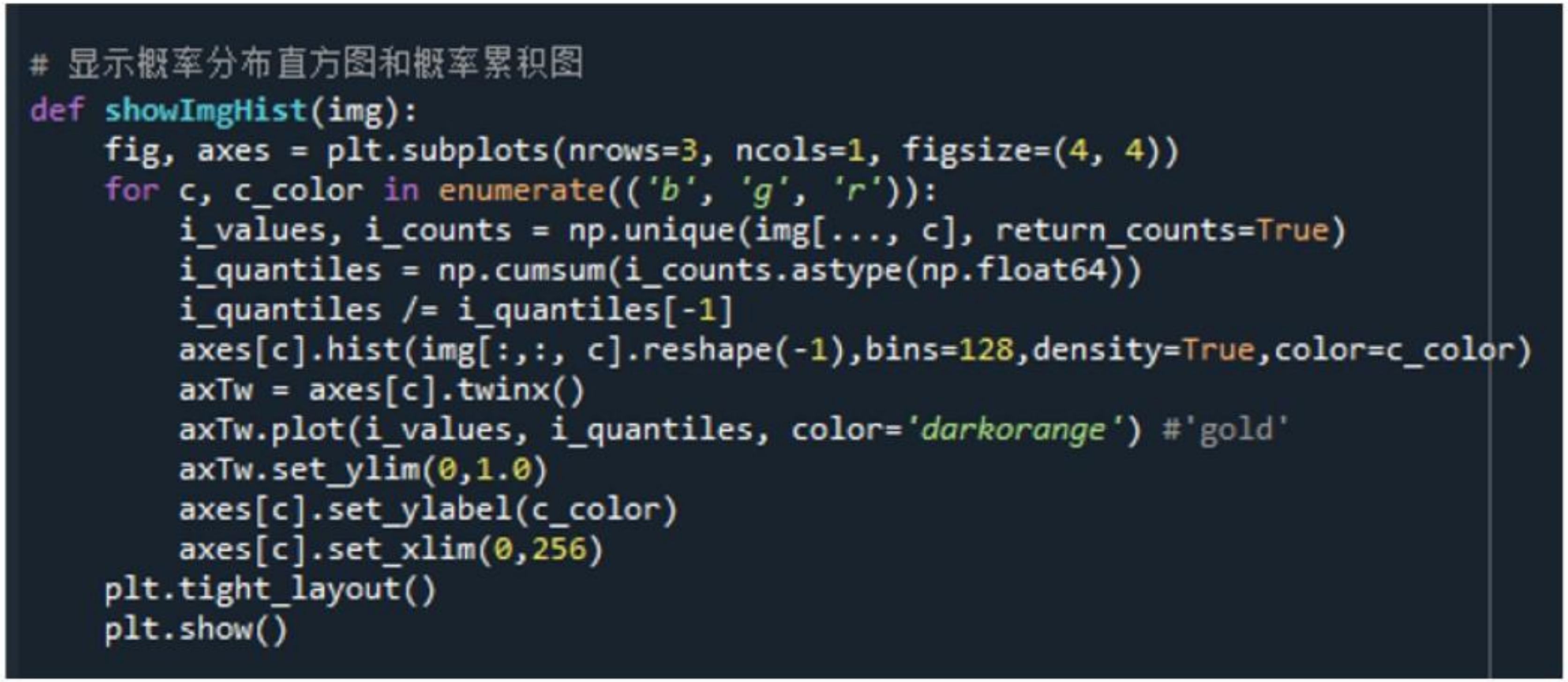
西北大学信息学院

pengshenglin@nwu.edu.cn

6 图像增强

6 图像增强

灰度值的概率分布与累积分布

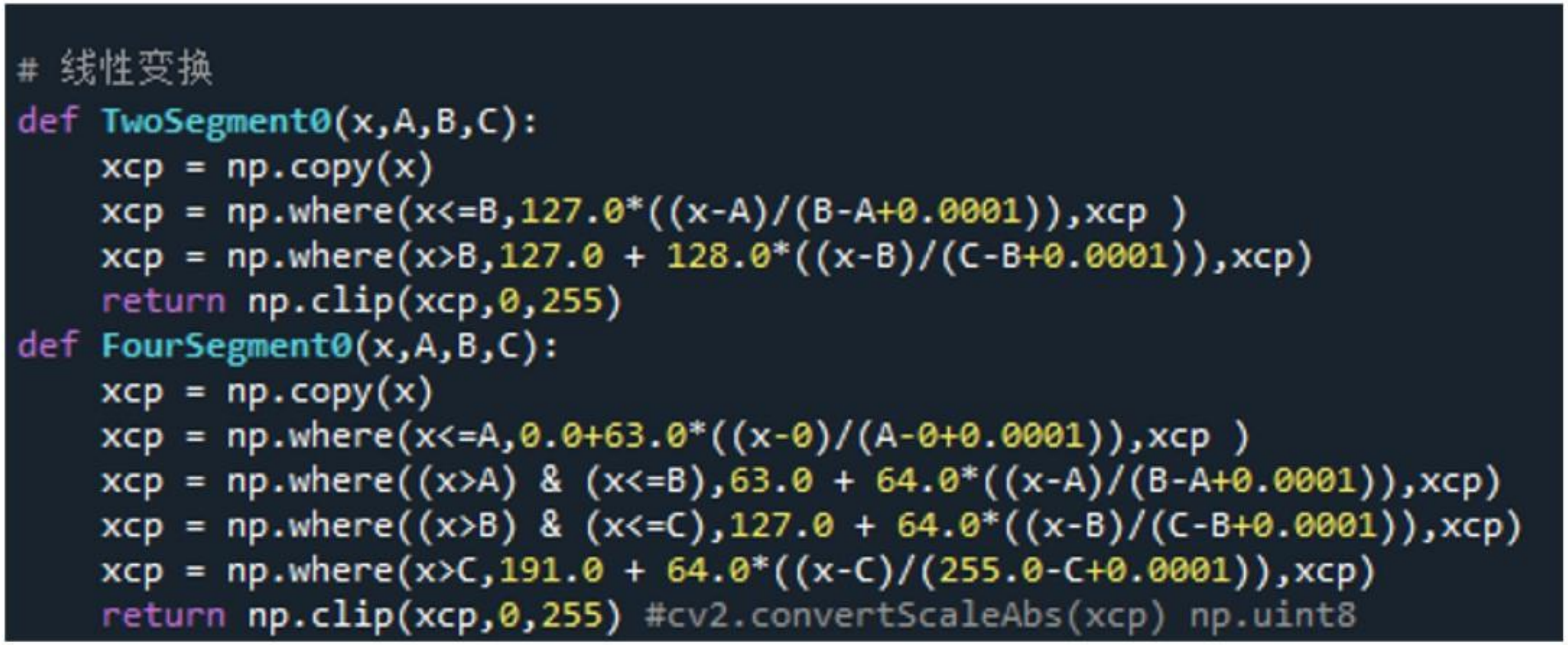


```
# 显示概率分布直方图和概率累积图
def showImgHist(img):
    fig, axes = plt.subplots(nrows=3, ncols=1, figsize=(4, 4))
    for c, c_color in enumerate(('b', 'g', 'r')):
        i_values, i_counts = np.unique(img[..., c], return_counts=True)
        i_quantiles = np.cumsum(i_counts.astype(np.float64))
        i_quantiles /= i_quantiles[-1]
        axes[c].hist(img[:,:, c].reshape(-1),bins=128,density=True,color=c_color)
        axTw = axes[c].twinx()
        axTw.plot(i_values, i_quantiles, color='darkorange') #'gold'
        axTw.set_ylim(0,1.0)
        axes[c].set_ylabel(c_color)
        axes[c].set_xlim(0,256)
    plt.tight_layout()
    plt.show()
```

可用于各种图像增强处理前后灰度直方图的变化对比

6 图像增强

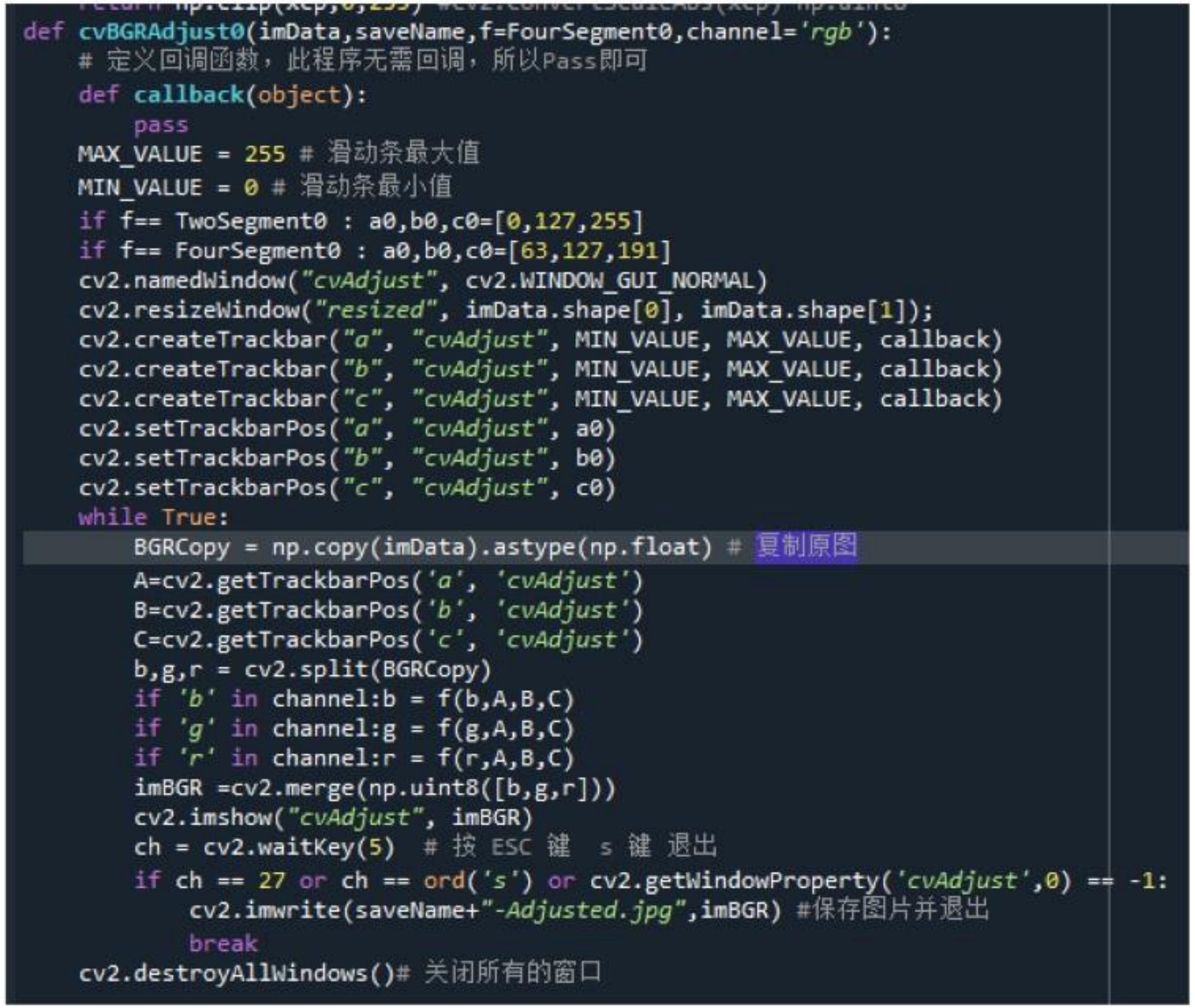
灰度变换



```
# 线性变换
def TwoSegment0(x,A,B,C):
    xcp = np.copy(x)
    xcp = np.where(x<=B,127.0*((x-A)/(B-A+0.0001)),xcp )
    xcp = np.where(x>B,127.0 + 128.0*((x-B)/(C-B+0.0001)),xcp)
    return np.clip(xcp,0,255)
def FourSegment0(x,A,B,C):
    xcp = np.copy(x)
    xcp = np.where(x<=A,0.0+63.0*((x-0)/(A-0+0.0001)),xcp )
    xcp = np.where((x>A) & (x<=B),63.0 + 64.0*((x-A)/(B-A+0.0001)),xcp)
    xcp = np.where((x>B) & (x<=C),127.0 + 64.0*((x-B)/(C-B+0.0001)),xcp)
    xcp = np.where(x>C,191.0 + 64.0*((x-C)/(255.0-C+0.0001)),xcp)
    return np.clip(xcp,0,255) #cv2.convertScaleAbs(xcp) np.uint8
```

6 图像增强

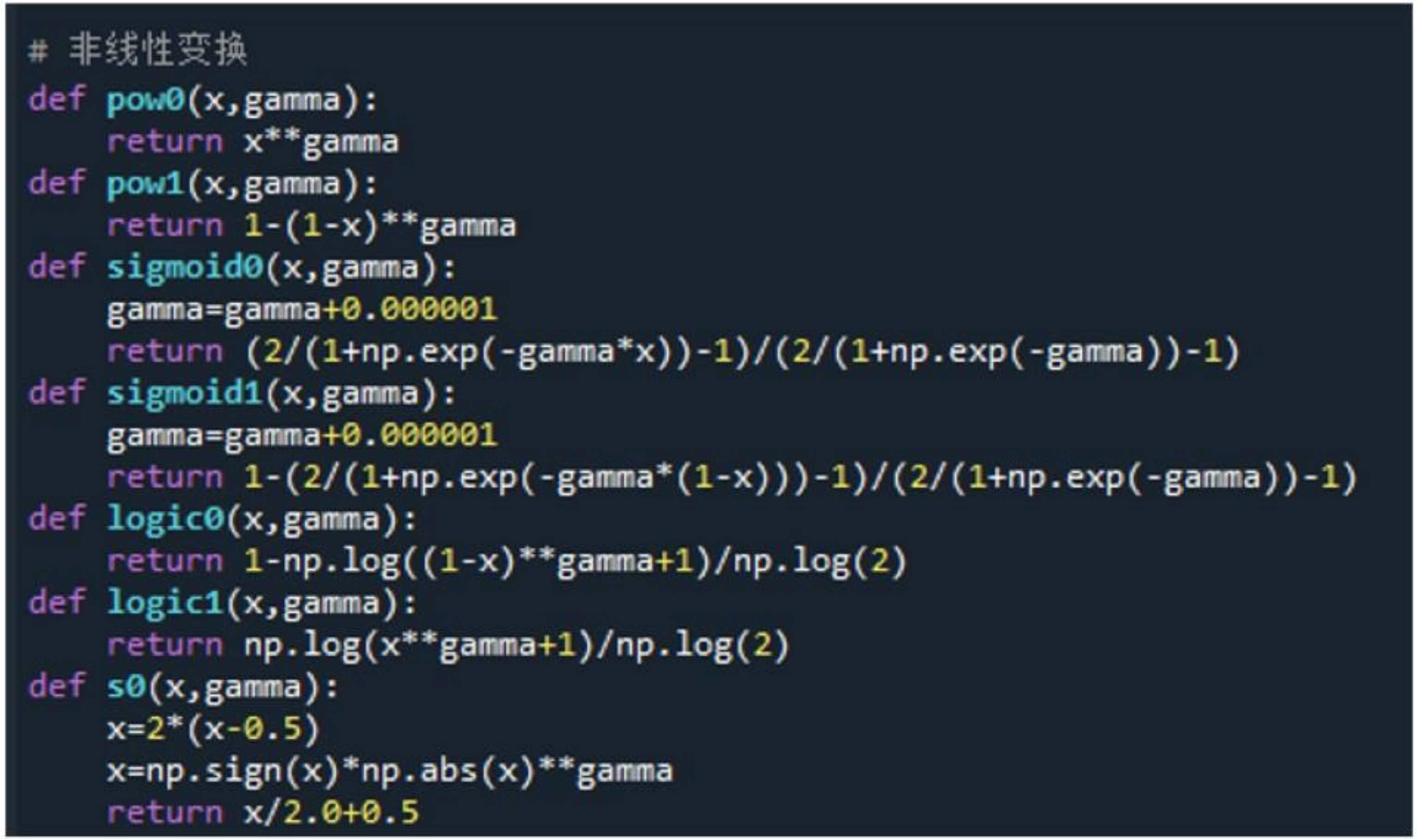
灰度变换



```
    return np.clip(xep,0,255) #cv2.convertScaleAbs(xep) np.uint8
def cvBGRAdjust0(imData,saveName,f=FourSegment0,channel='rgb'):
    # 定义回调函数，此程序无需回调，所以Pass即可
    def callback(object):
        pass
    MAX_VALUE = 255 # 滑动条最大值
    MIN_VALUE = 0 # 滑动条最小值
    if f== TwoSegment0 : a0,b0,c0=[0,127,255]
    if f== FourSegment0 : a0,b0,c0=[63,127,191]
    cv2.namedWindow("cvAdjust", cv2.WINDOW_GUI_NORMAL)
    cv2.resizeWindow("resized", imData.shape[0], imData.shape[1]);
    cv2.createTrackbar("a", "cvAdjust", MIN_VALUE, MAX_VALUE, callback)
    cv2.createTrackbar("b", "cvAdjust", MIN_VALUE, MAX_VALUE, callback)
    cv2.createTrackbar("c", "cvAdjust", MIN_VALUE, MAX_VALUE, callback)
    cv2.setTrackbarPos("a", "cvAdjust", a0)
    cv2.setTrackbarPos("b", "cvAdjust", b0)
    cv2.setTrackbarPos("c", "cvAdjust", c0)
    while True:
        BGRCopy = np.copy(imData).astype(np.float) # 复制原图
        A=cv2.getTrackbarPos('a', 'cvAdjust')
        B=cv2.getTrackbarPos('b', 'cvAdjust')
        C=cv2.getTrackbarPos('c', 'cvAdjust')
        b,g,r = cv2.split(BGRCopy)
        if 'b' in channel:b = f(b,A,B,C)
        if 'g' in channel:g = f(g,A,B,C)
        if 'r' in channel:r = f(r,A,B,C)
        imBGR =cv2.merge(np.uint8([b,g,r]))
        cv2.imshow("cvAdjust", imBGR)
        ch = cv2.waitKey(5)  # 按 ESC 键 s 键 退出
        if ch == 27 or ch == ord('s') or cv2.getWindowProperty('cvAdjust',0) == -1:
            cv2.imwrite(saveName+"-Adjusted.jpg",imBGR) #保存图片并退出
            break
    cv2.destroyAllWindows()# 关闭所有的窗口
```

6 图像增强

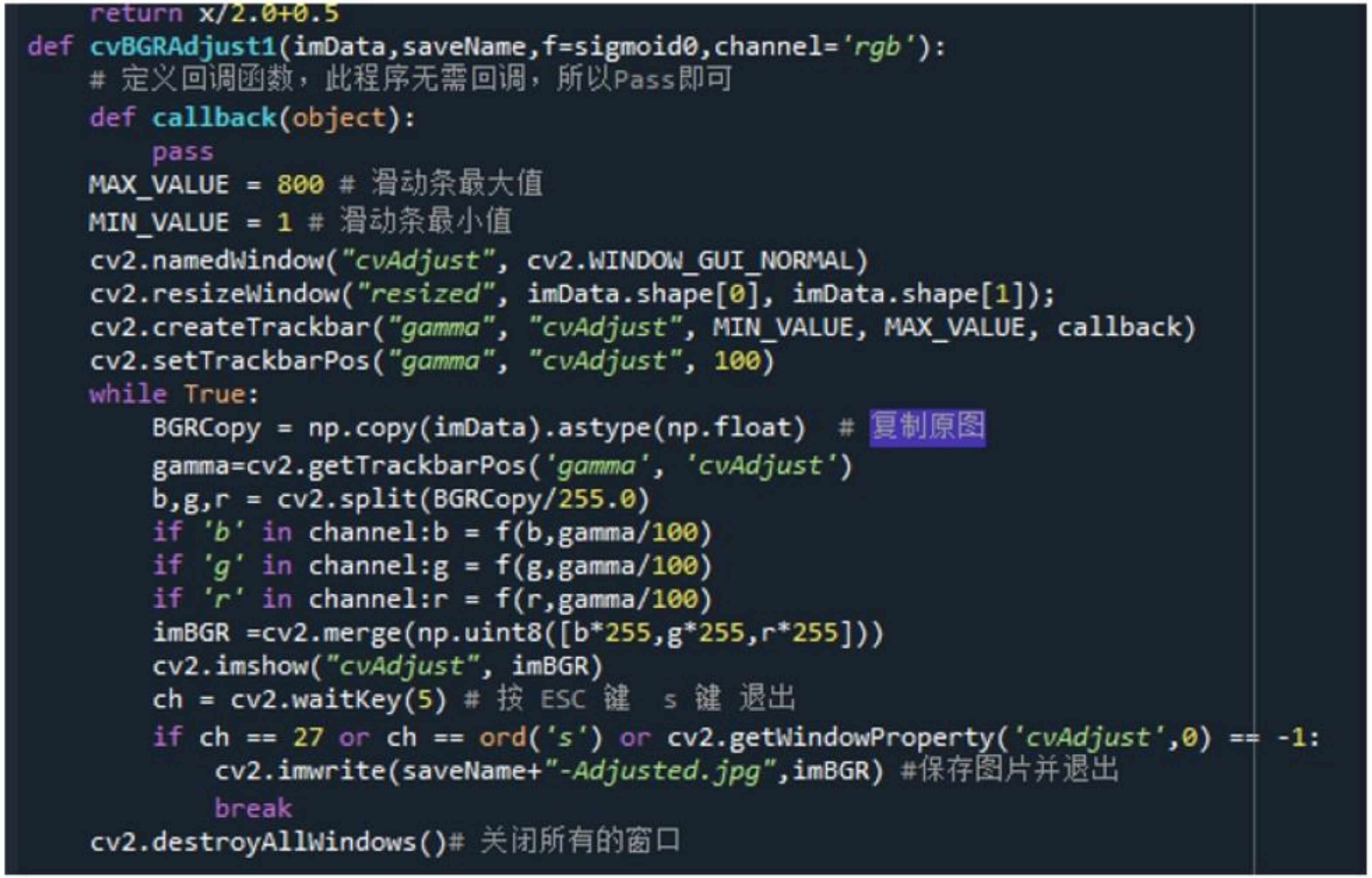
灰度变换



```python
# 非线性变换
def pow0(x,gamma):
    return x**gamma
def pow1(x,gamma):
    return 1-(1-x)**gamma
def sigmoid0(x,gamma):
    gamma=gamma+0.000001
    return (2/(1+np.exp(-gamma*x))-1)/(2/(1+np.exp(-gamma))-1)
def sigmoid1(x,gamma):
    gamma=gamma+0.000001
    return 1-(2/(1+np.exp(-gamma*(1-x)))-1)/(2/(1+np.exp(-gamma))-1)
def logic0(x,gamma):
    return 1-np.log((1-x)**gamma+1)/np.log(2)
def logic1(x,gamma):
    return np.log(x**gamma+1)/np.log(2)
def s0(x,gamma):
    x=2*(x-0.5)
    x=np.sign(x)*np.abs(x)**gamma
    return x/2.0+0.5
```

6 图像增强

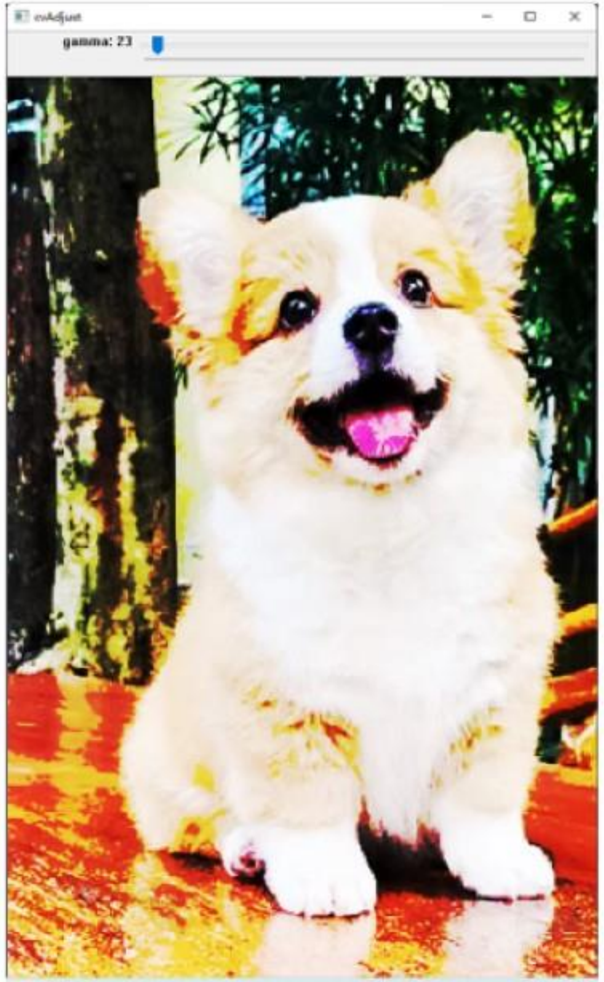
灰度变换



```python
    return x/2.0+0.5
def cvBGRAdjust1(imData,saveName,f=sigmoid0,channel='rgb'):
    # 定义回调函数，此程序无需回调，所以Pass即可
    def callback(object):
        pass
    MAX_VALUE = 800 # 滑动条最大值
    MIN_VALUE = 1 # 滑动条最小值
    cv2.namedWindow("cvAdjust", cv2.WINDOW_GUI_NORMAL)
    cv2.resizeWindow("resized", imData.shape[0], imData.shape[1]);
    cv2.createTrackbar("gamma", "cvAdjust", MIN_VALUE, MAX_VALUE, callback)
    cv2.setTrackbarPos("gamma", "cvAdjust", 100)
    while True:
        BGRCopy = np.copy(imData).astype(np.float)  # 复制原图
        gamma=cv2.getTrackbarPos('gamma', 'cvAdjust')
        b,g,r = cv2.split(BGRCopy/255.0)
        if 'b' in channel:b = f(b,gamma/100)
        if 'g' in channel:g = f(g,gamma/100)
        if 'r' in channel:r = f(r,gamma/100)
        imBGR =cv2.merge(np.uint8([b*255,g*255,r*255]))
        cv2.imshow("cvAdjust", imBGR)
        ch = cv2.waitKey(5) # 按 ESC 鍵  s 鍵 退出
        if ch == 27 or ch == ord('s') or cv2.getWindowProperty('cvAdjust',0) == -1:
            cv2.imwrite(saveName+"-Adjusted.jpg",imBGR) #保存图片并退出
            break
    cv2.destroyAllWindows()# 关闭所有的窗口
```

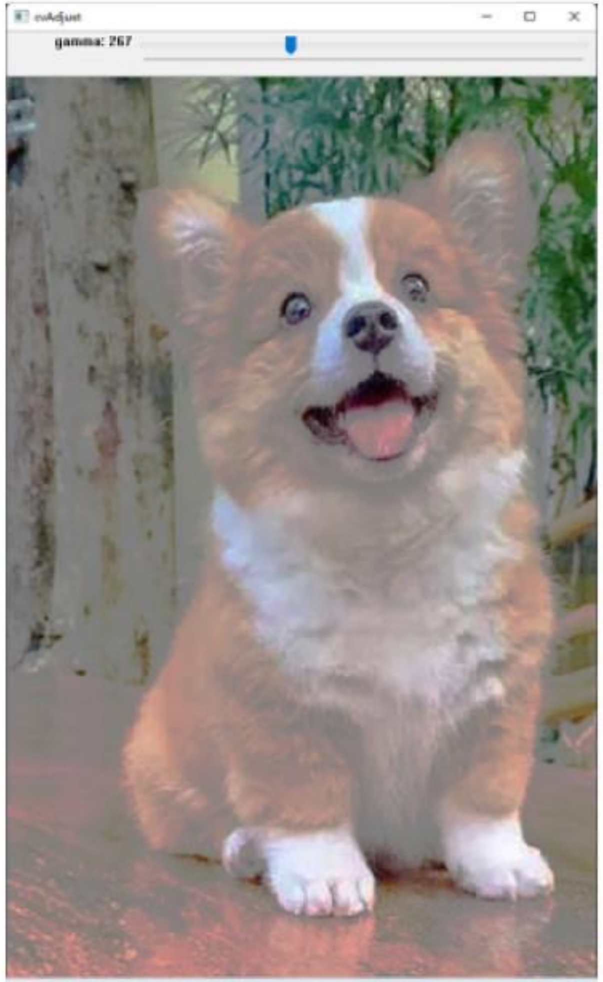
6 图像增强

灰度变换



cvAdjust

gamma: 23



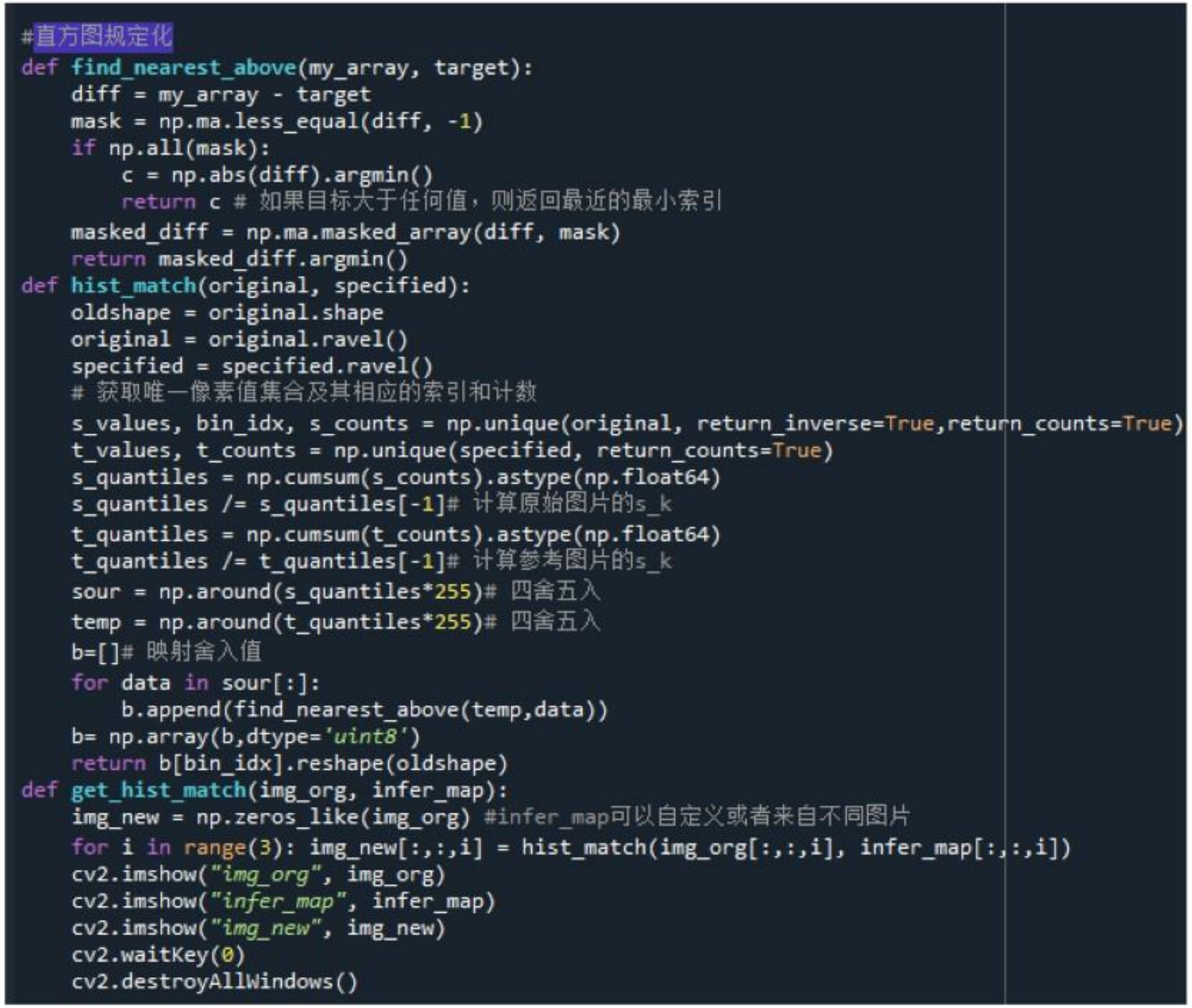
cvAdjust

gamma: 267

非线性变换，变换函数取自定义S型曲线s0，可调节对比度

6 图像增强

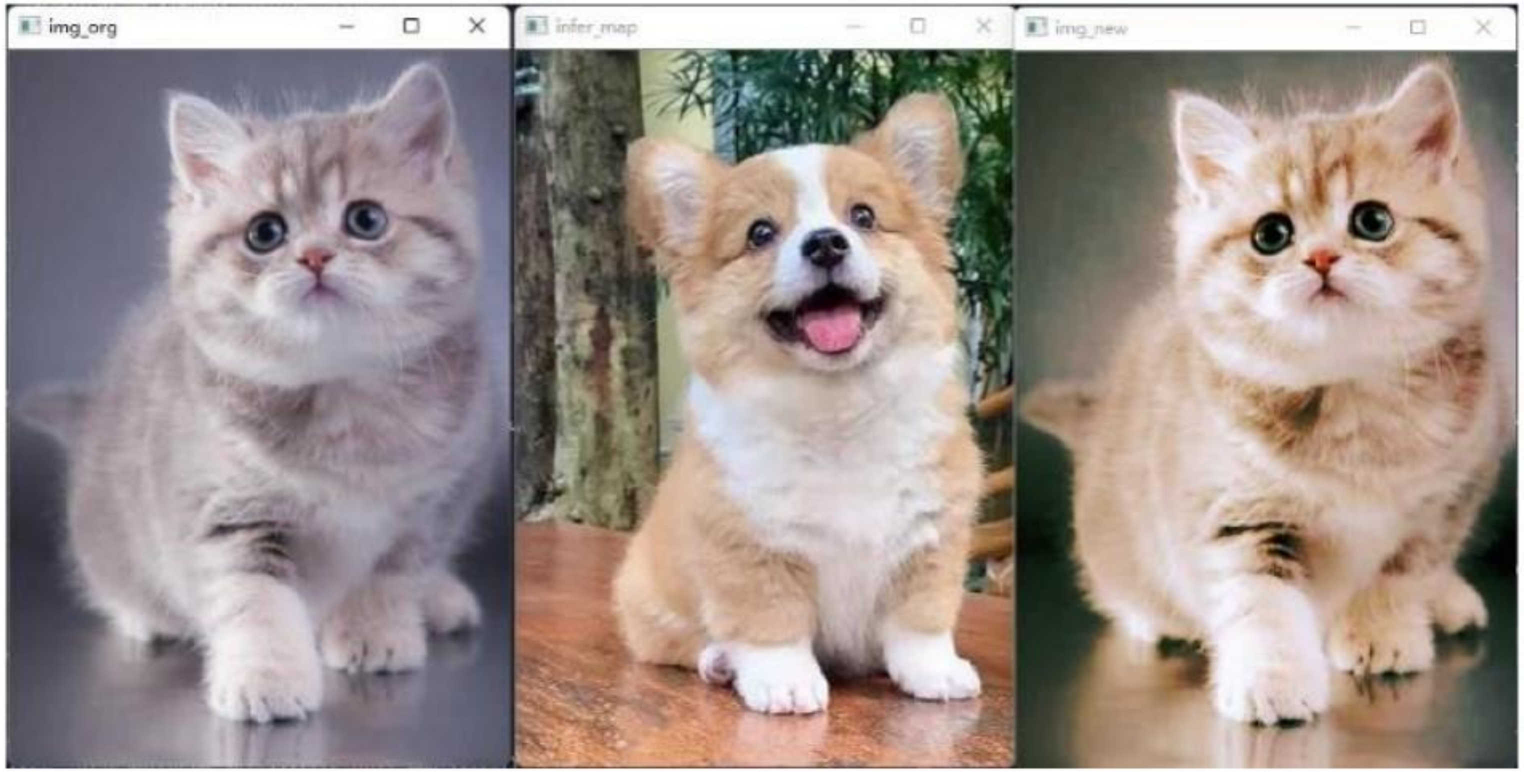
直方图规定化



```
#直方图规定化
def find_nearest_above(my_array, target):
    diff = my_array - target
    mask = np.ma.less_equal(diff, -1)
    if np.all(mask):
        c = np.abs(diff).argmin()
        return c # 如果目标大于任何值，则返回最近的最小索引
    masked_diff = np.ma.masked_array(diff, mask)
    return masked_diff.argmin()
def hist_match(original, specified):
    oldshape = original.shape
    original = original.ravel()
    specified = specified.ravel()
    # 获取唯一像素值集合及其相应的索引和计数
    s_values, bin_idx, s_counts = np.unique(original, return_inverse=True,return_counts=True)
    t_values, t_counts = np.unique(specified, return_counts=True)
    s_quantiles = np.cumsum(s_counts).astype(np.float64)
    s_quantiles /= s_quantiles[-1]# 计算原始图片的s_k
    t_quantiles = np.cumsum(t_counts).astype(np.float64)
    t_quantiles /= t_quantiles[-1]# 计算参考图片的s_k
    sour = np.around(s_quantiles*255)# 四舍五入
    temp = np.around(t_quantiles*255)# 四舍五入
    b=[]# 映射舍入值
    for data in sour[:]:
        b.append(find_nearest_above(temp,data))
    b= np.array(b,dtype='uint8')
    return b[bin_idx].reshape(oldshape)
def get_hist_match(img_org, infer_map):
    img_new = np.zeros_like(img_org) #infer_map可以自定义或者来自不同图片
    for i in range(3): img_new[:,:,i] = hist_match(img_org[:,:,i], infer_map[:,:,i])
    cv2.imshow("img_org", img_org)
    cv2.imshow("infer_map", infer_map)
    cv2.imshow("img_new", img_new)
    cv2.waitKey(0)
    cv2.destroyAllWindows()
```

6 图像增强

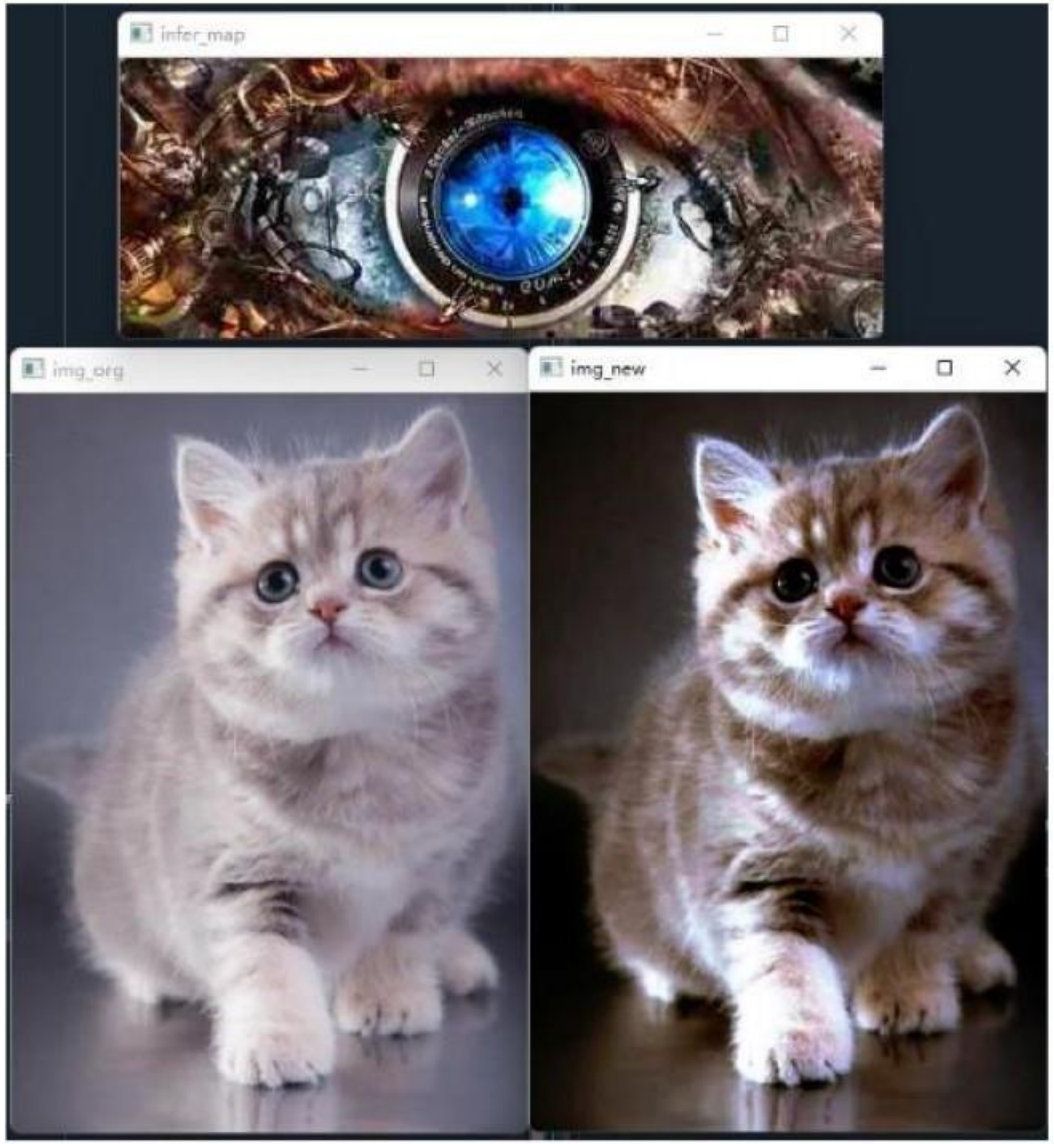
直方图规定化



参考infer_map给img_org配色

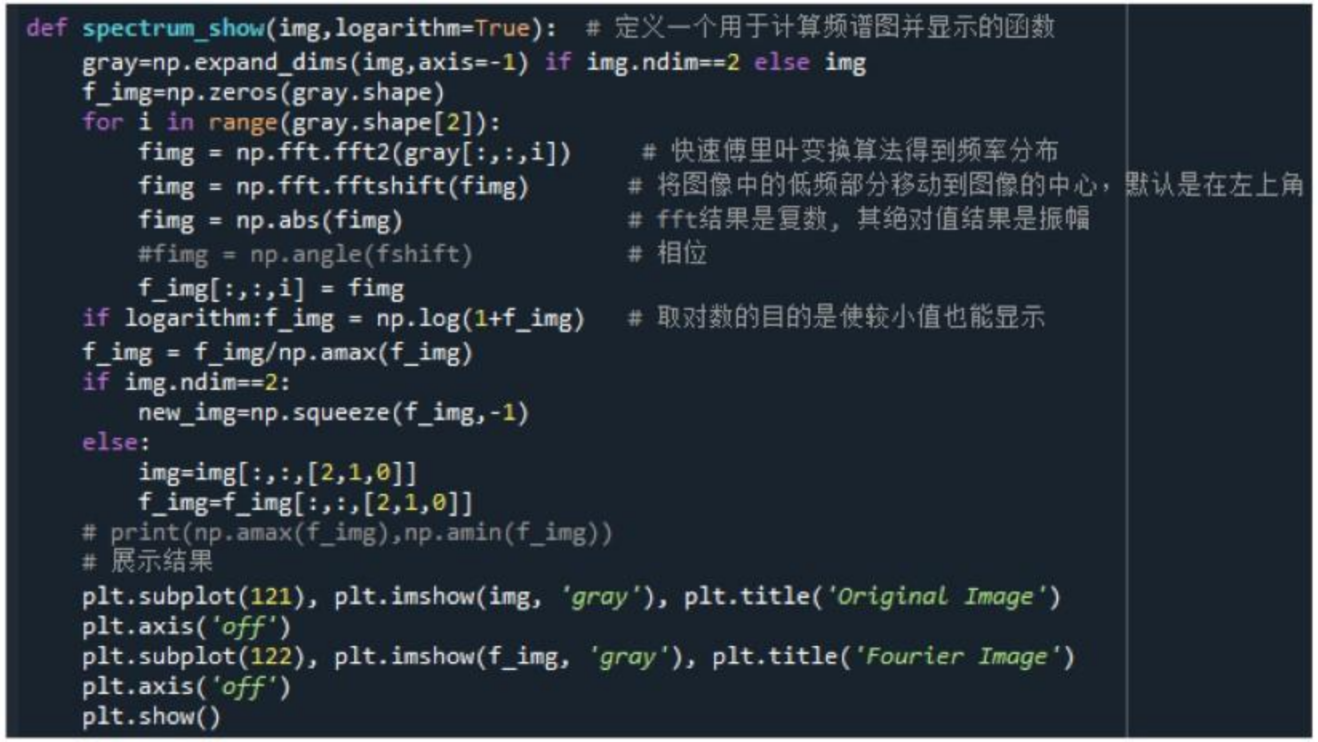
6 图像增强

直方图规定化



6 图像增强

显示频谱图

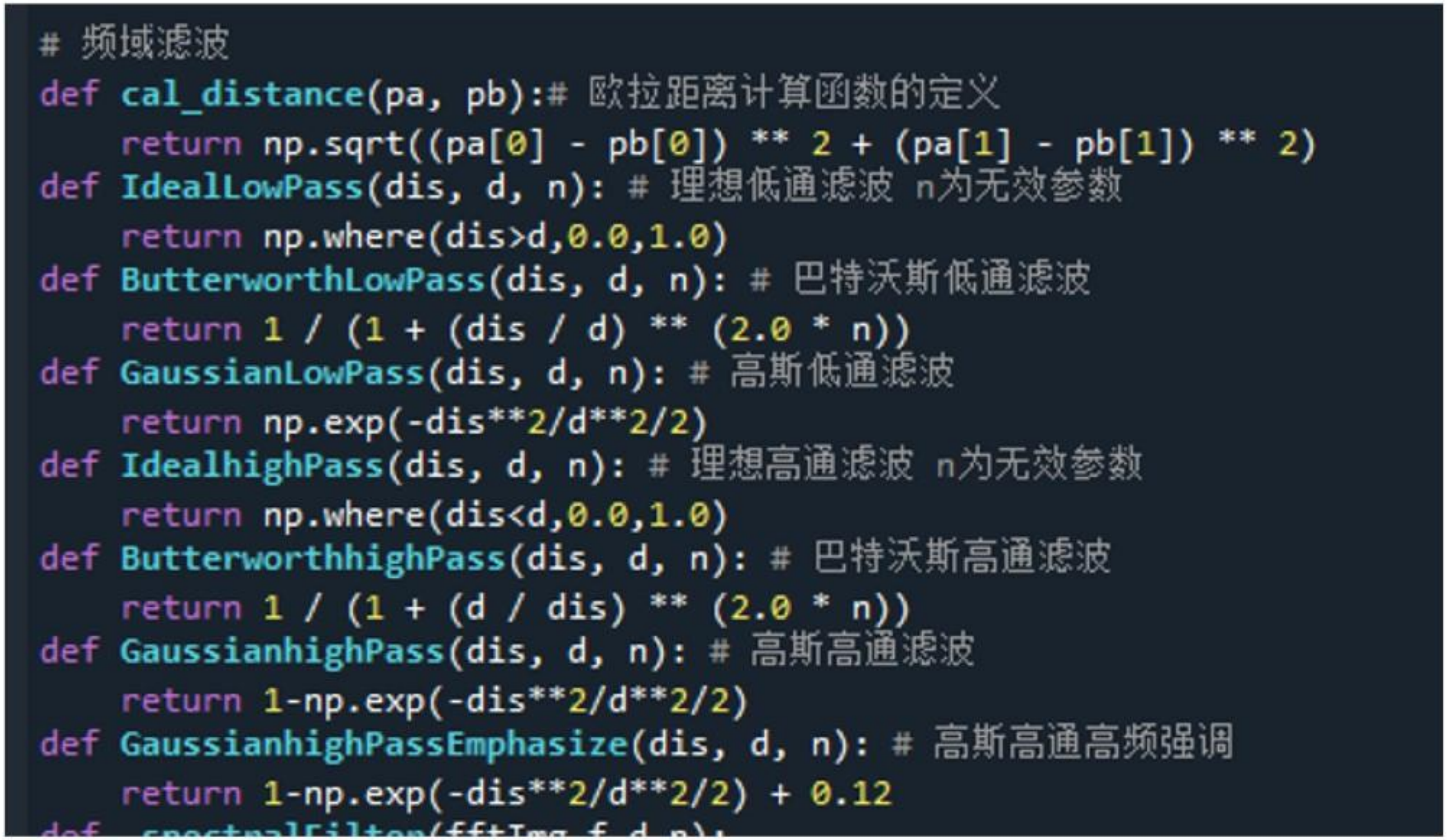


```python
def spectrum_show(img,logarithm=True):  # 定义一个用于计算频谱图并显示的函数
    gray=np.expand_dims(img,axis=-1) if img.ndim==2 else img
    f_img=np.zeros(gray.shape)
    for i in range(gray.shape[2]):
        fimg = np.fft.fft2(gray[:,:,i])     # 快速傅里叶变换算法得到频率分布
        fimg = np.fft.fftshift(fimg)       # 将图像中的低频部分移动到图像的中心，默认是在左上角
        fimg = np.abs(fimg)                # fft结果是复数, 其绝对值结果是振幅
        #fimg = np.angle(fshift)           # 相位
        f_img[:,:,i] = fimg
    if logarithm:f_img = np.log(1+f_img)   # 取对数的目的是使较小值也能显示
    f_img = f_img/np.amax(f_img)
    if img.ndim==2:
        new_img=np.squeeze(f_img,-1)
    else:
        img=img[:,:,[2,1,0]]
        f_img=f_img[:,:,[2,1,0]]
    # print(np.amax(f_img),np.amin(f_img))
    # 展示结果
    plt.subplot(121), plt.imshow(img, 'gray'), plt.title('Original Image')
    plt.axis('off')
    plt.subplot(122), plt.imshow(f_img, 'gray'), plt.title('Fourier Image')
    plt.axis('off')
    plt.show()
```

可用于各种图像增强处理前后频域图像的变化对比

6 图像增强

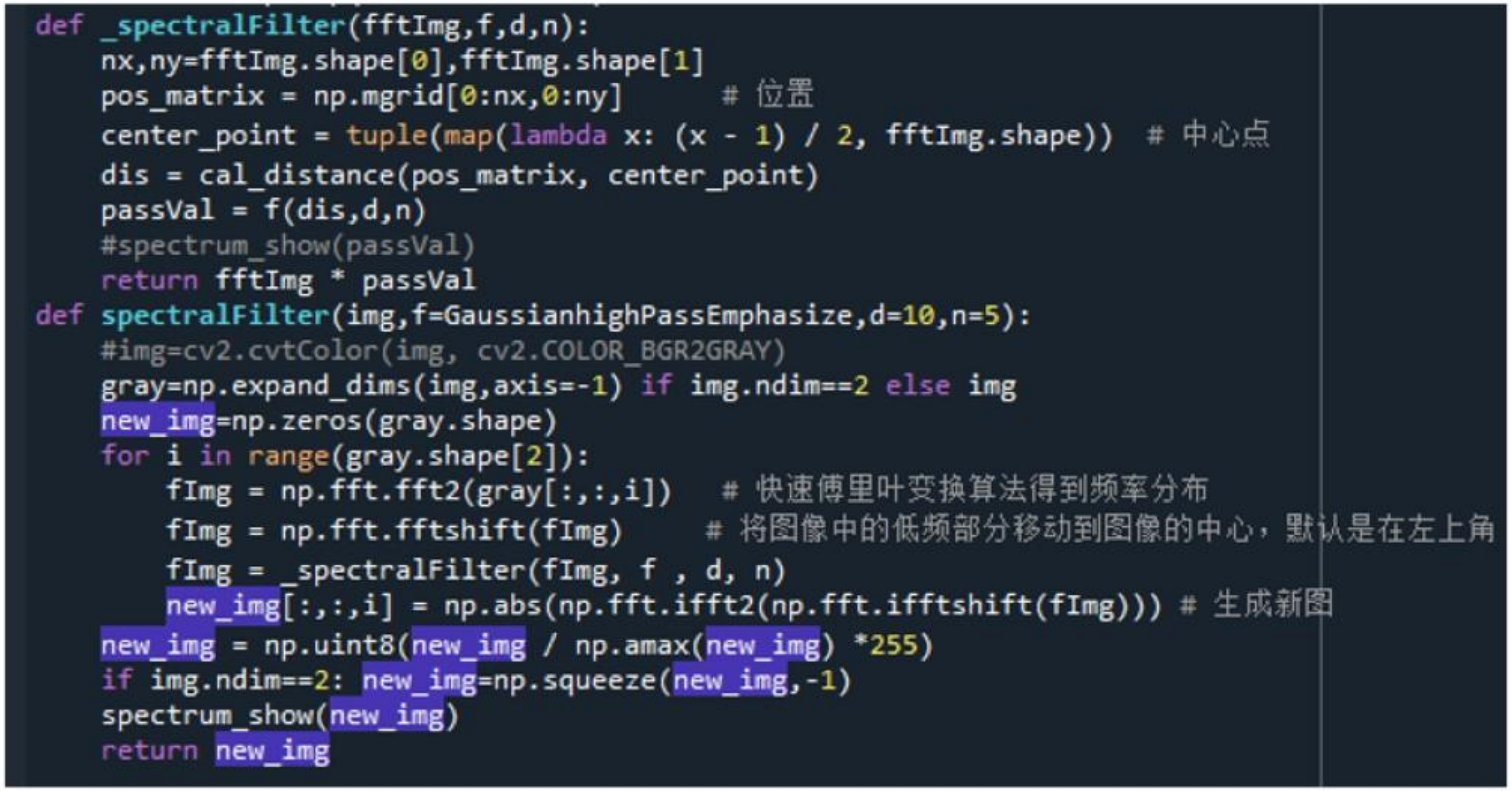
频域滤波



```
# 频域滤波
def cal_distance(pa, pb):# 欧拉距离计算函数的定义
    return np.sqrt((pa[0] - pb[0]) ** 2 + (pa[1] - pb[1]) ** 2)
def IdealLowPass(dis, d, n): # 理想低通滤波 n为无效参数
    return np.where(dis>d,0.0,1.0)
def ButterworthLowPass(dis, d, n): # 巴特沃斯低通滤波
    return 1 / (1 + (dis / d) ** (2.0 * n))
def GaussianLowPass(dis, d, n): # 高斯低通滤波
    return np.exp(-dis**2/d**2/2)
def IdealhighPass(dis, d, n): # 理想高通滤波 n为无效参数
    return np.where(dis<d,0.0,1.0)
def ButterworthhighPass(dis, d, n): # 巴特沃斯高通滤波
    return 1 / (1 + (d / dis) ** (2.0 * n))
def GaussianhighPass(dis, d, n): # 高斯高通滤波
    return 1-np.exp(-dis**2/d**2/2)
def GaussianhighPassEmphasize(dis, d, n): # 高斯高通高频强调
    return 1-np.exp(-dis**2/d**2/2) + 0.12
def  spectralFilter(fftImg,f,d,n):
```

6 图像增强

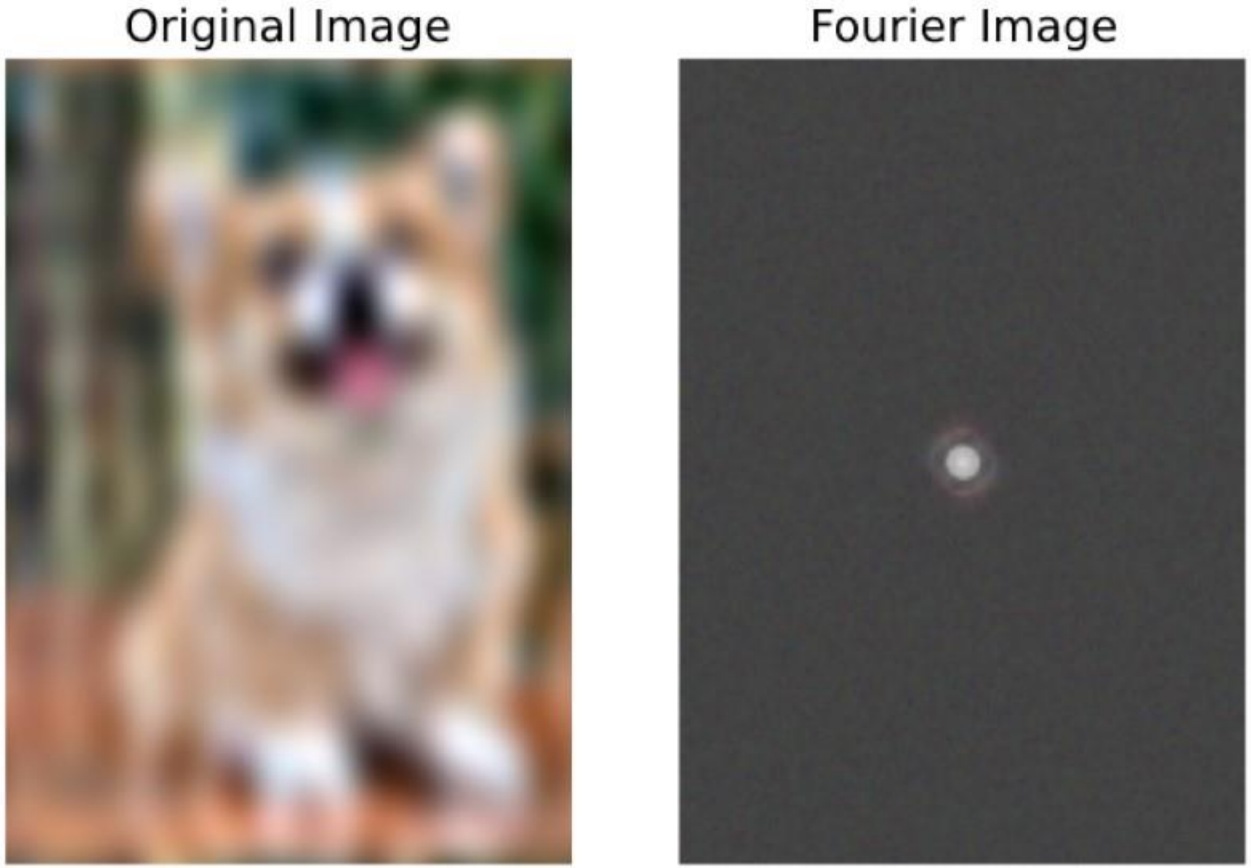
频域滤波



```
def _spectralFilter(fftImg,f,d,n):
    nx,ny=fftImg.shape[0],fftImg.shape[1]
    pos_matrix = np.mgrid[0:nx,0:ny]      # 位置
    center_point = tuple(map(lambda x: (x - 1) / 2, fftImg.shape))  # 中心点
    dis = cal_distance(pos_matrix, center_point)
    passVal = f(dis,d,n)
    #spectrum_show(passVal)
    return fftImg * passVal
def spectralFilter(img,f=GaussianhighPassEmphasize,d=10,n=5):
    #img=cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    gray=np.expand_dims(img,axis=-1) if img.ndim==2 else img
    new_img=np.zeros(gray.shape)
    for i in range(gray.shape[2]):
        fImg = np.fft.fft2(gray[:,:,i])   # 快速傅里叶变换算法得到频率分布
        fImg = np.fft.fftshift(fImg)     # 将图像中的低频部分移动到图像的中心，默认是在左上角
        fImg = _spectralFilter(fImg, f , d, n)
        new_img[:,:,i] = np.abs(np.fft.ifft2(np.fft.ifftshift(fImg))) # 生成新图
    new_img = np.uint8(new_img / np.amax(new_img) *255)
    if img.ndim==2: new_img=np.squeeze(new_img,-1)
    spectrum_show(new_img)
    return new_img
```

6 图像增强

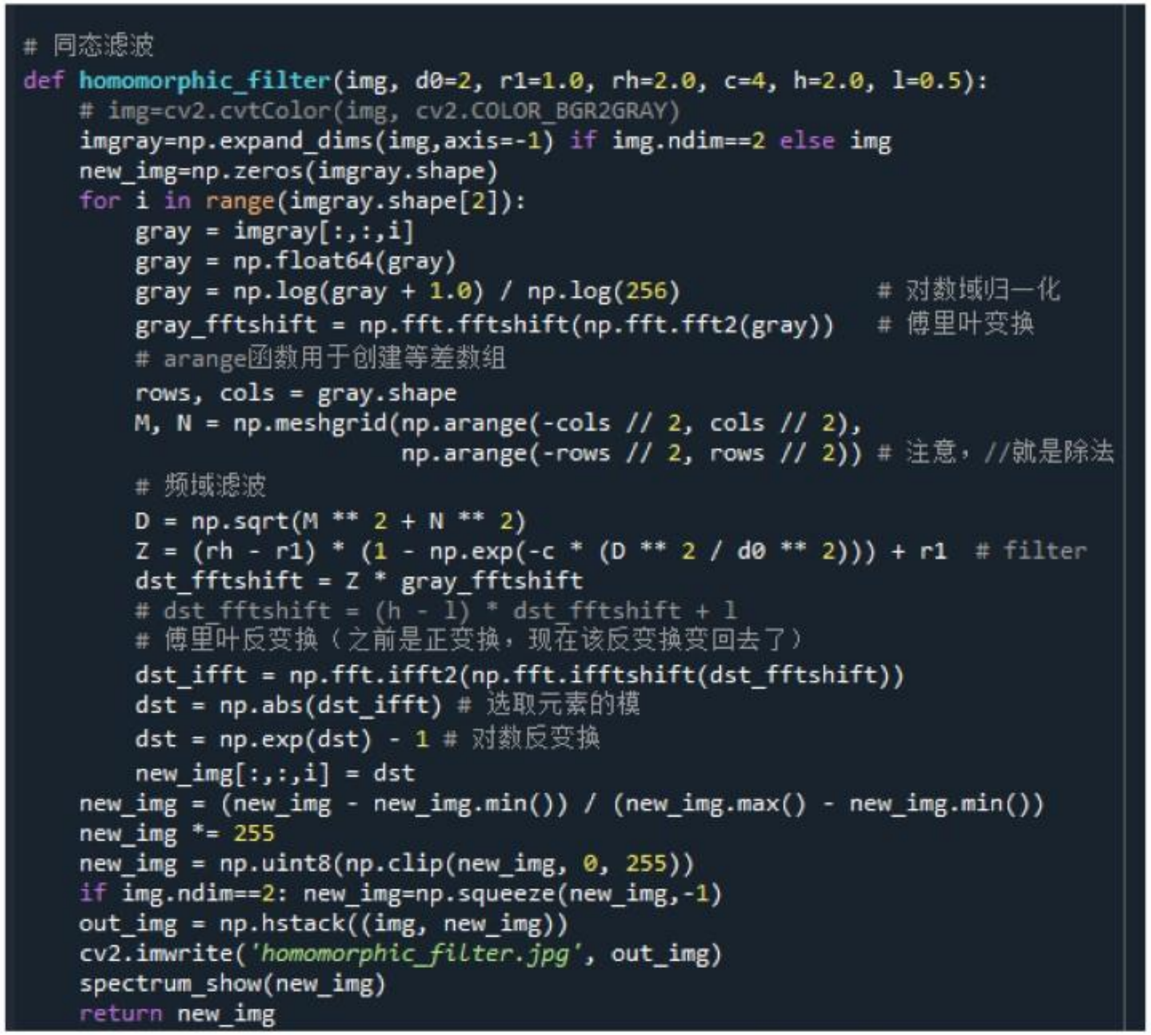
频域滤波



IdealLowPass, d=10, n=5

6 图像增强

同态滤波

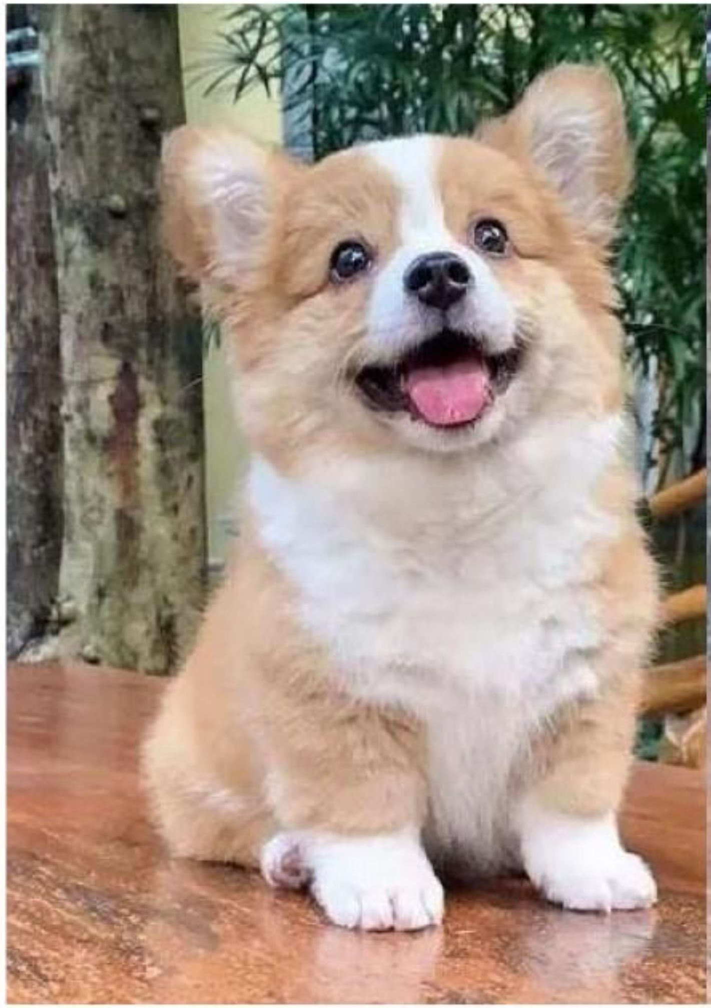


```python
# 同态滤波
def homomorphic_filter(img, d0=2, r1=1.0, rh=2.0, c=4, h=2.0, l=0.5):
    # img=cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    imgray=np.expand_dims(img,axis=-1) if img.ndim==2 else img
    new_img=np.zeros(imgray.shape)
    for i in range(imgray.shape[2]):
        gray = imgray[:,:,i]
        gray = np.float64(gray)
        gray = np.log(gray + 1.0) / np.log(256)             # 对数域归一化
        gray_fftshift = np.fft.fftshift(np.fft.fft2(gray))   # 傅里叶变换
        # arange函数用于创建等差数组
        rows, cols = gray.shape
        M, N = np.meshgrid(np.arange(-cols // 2, cols // 2),
                           np.arange(-rows // 2, rows // 2)) # 注意，//就是除法
        # 频域滤波
        D = np.sqrt(M ** 2 + N ** 2)
        Z = (rh - r1) * (1 - np.exp(-c * (D ** 2 / d0 ** 2))) + r1  # filter
        dst_fftshift = Z * gray_fftshift
        # dst_fftshift = (h - l) * dst_fftshift + l
        # 傅里叶反变换（之前是正变换，现在该反变换变回去了）
        dst_ifft = np.fft.ifft2(np.fft.ifftshift(dst_fftshift))
        dst = np.abs(dst_ifft) # 选取元素的模
        dst = np.exp(dst) - 1 # 对数反变换
        new_img[:,:,i] = dst
    new_img = (new_img - new_img.min()) / (new_img.max() - new_img.min())
    new_img *= 255
    new_img = np.uint8(np.clip(new_img, 0, 255))
    if img.ndim==2: new_img=np.squeeze(new_img,-1)
    out_img = np.hstack((img, new_img))
    cv2.imwrite('homomorphic_filter.jpg', out_img)
    spectrum_show(new_img)
    return new_img
```

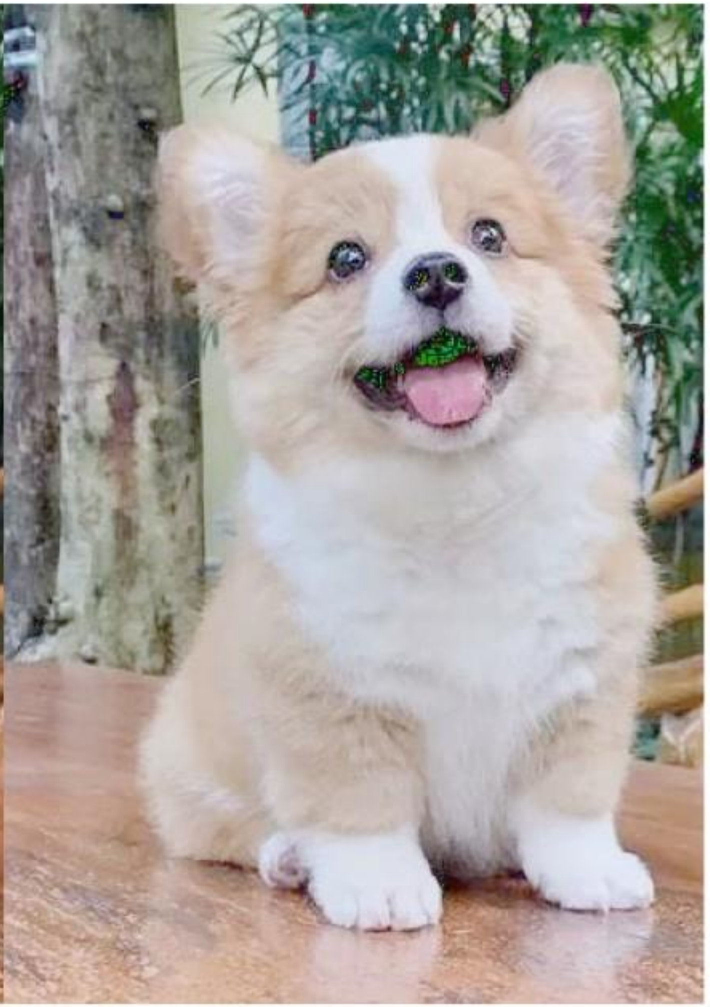
RGB 三个通道分别滤波

6 图像增强

同态滤波



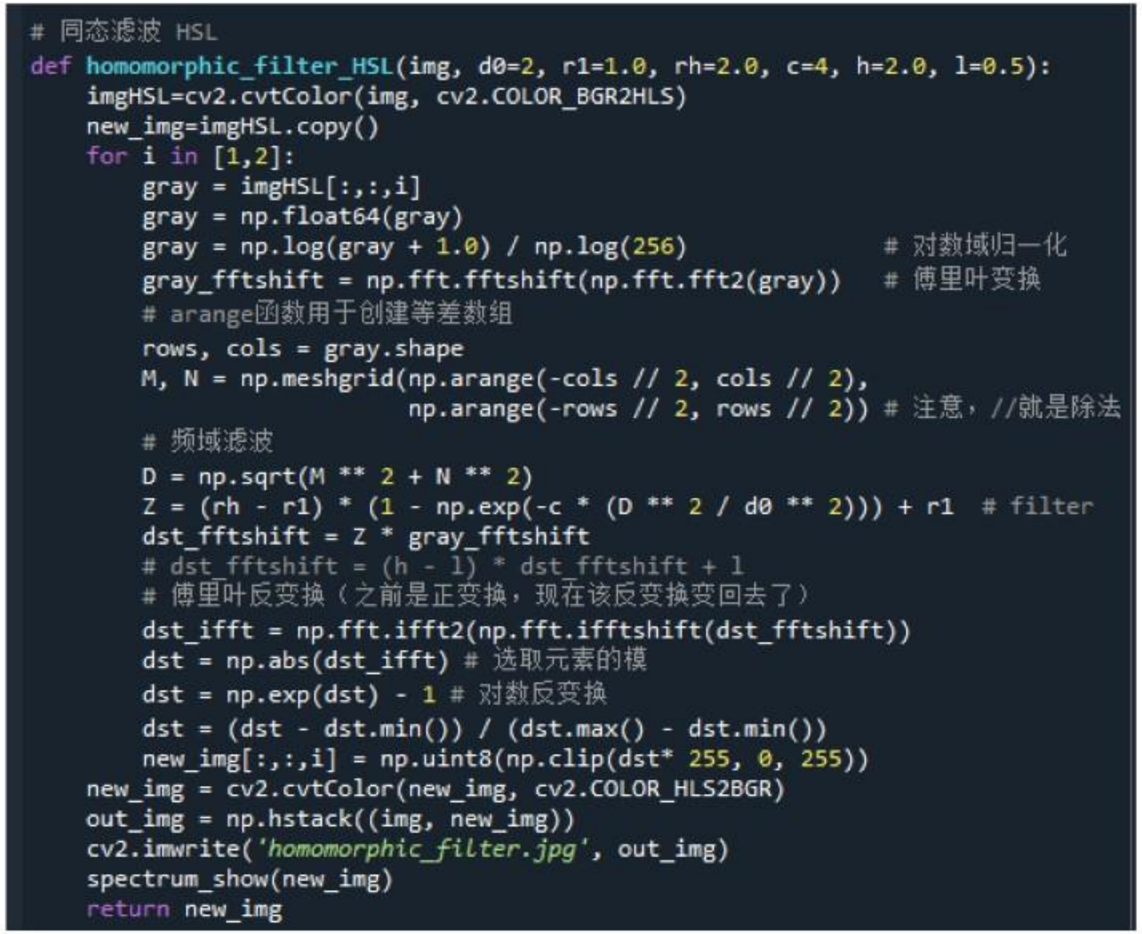
滤波前



滤波后

6 图像增强

同态滤波

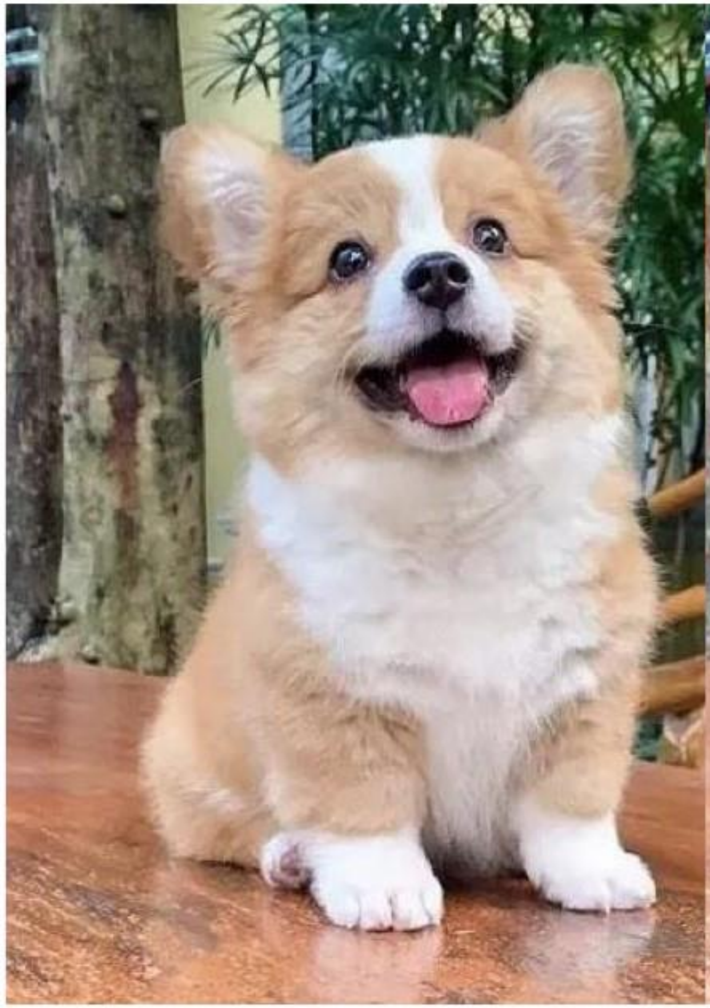


```
# 同态滤波 HSL
def homomorphic_filter_HSL(img, d0=2, r1=1.0, rh=2.0, c=4, h=2.0, l=0.5):
    imgHSL=cv2.cvtColor(img, cv2.COLOR_BGR2HLS)
    new_img=imgHSL.copy()
    for i in [1,2]:
        gray = imgHSL[:,:,i]
        gray = np.float64(gray)
        gray = np.log(gray + 1.0) / np.log(256)             # 对数域归一化
        gray_fftshift = np.fft.fftshift(np.fft.fft2(gray))   # 傅里叶变换
        # arange函数用于创建等差数组
        rows, cols = gray.shape
        M, N = np.meshgrid(np.arange(-cols // 2, cols // 2),
                           np.arange(-rows // 2, rows // 2)) # 注意，//就是除法
        # 频域滤波
        D = np.sqrt(M ** 2 + N ** 2)
        Z = (rh - r1) * (1 - np.exp(-c * (D ** 2 / d0 ** 2))) + r1  # filter
        dst_fftshift = Z * gray_fftshift
        # dst_fftshift = (h - l) * dst_fftshift + l
        # 傅里叶反变换（之前是正变换，现在该反变换变回去了）
        dst_ifft = np.fft.ifft2(np.fft.ifftshift(dst_fftshift))
        dst = np.abs(dst_ifft) # 选取元素的模
        dst = np.exp(dst) - 1 # 对数反变换
        dst = (dst - dst.min()) / (dst.max() - dst.min())
        new_img[:,:,i] = np.uint8(np.clip(dst* 255, 0, 255))
    new_img = cv2.cvtColor(new_img, cv2.COLOR_HLS2BGR)
    out_img = np.hstack((img, new_img))
    cv2.imwrite('homomorphic_filter.jpg', out_img)
    spectrum_show(new_img)
    return new_img
```

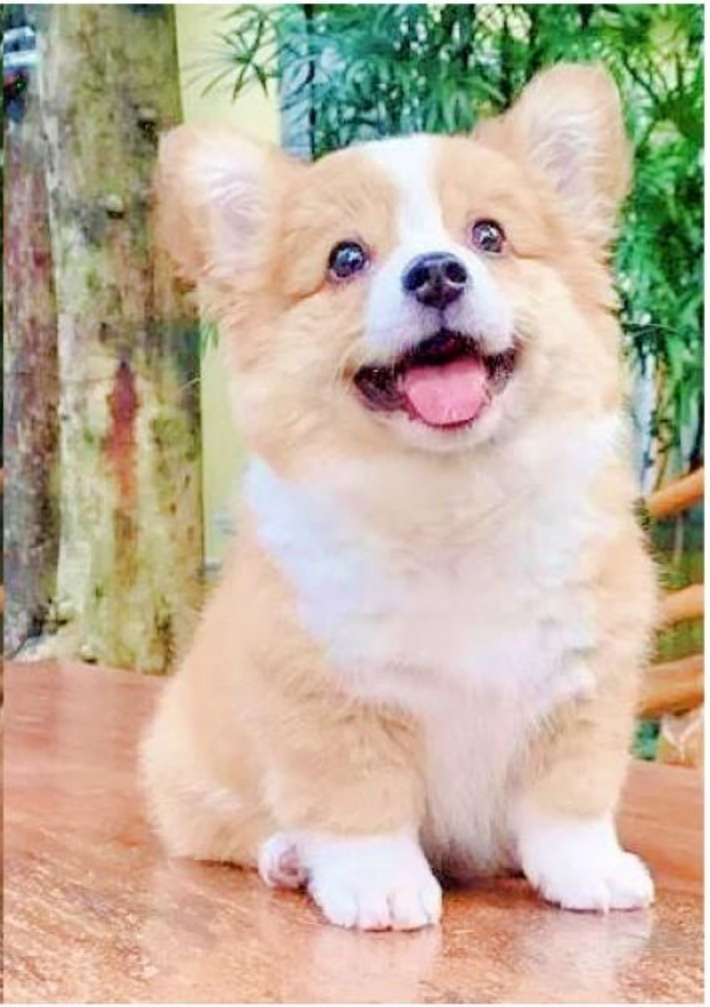
HSL SL两个通道分别滤波，H不变

6 图像增强

同态滤波



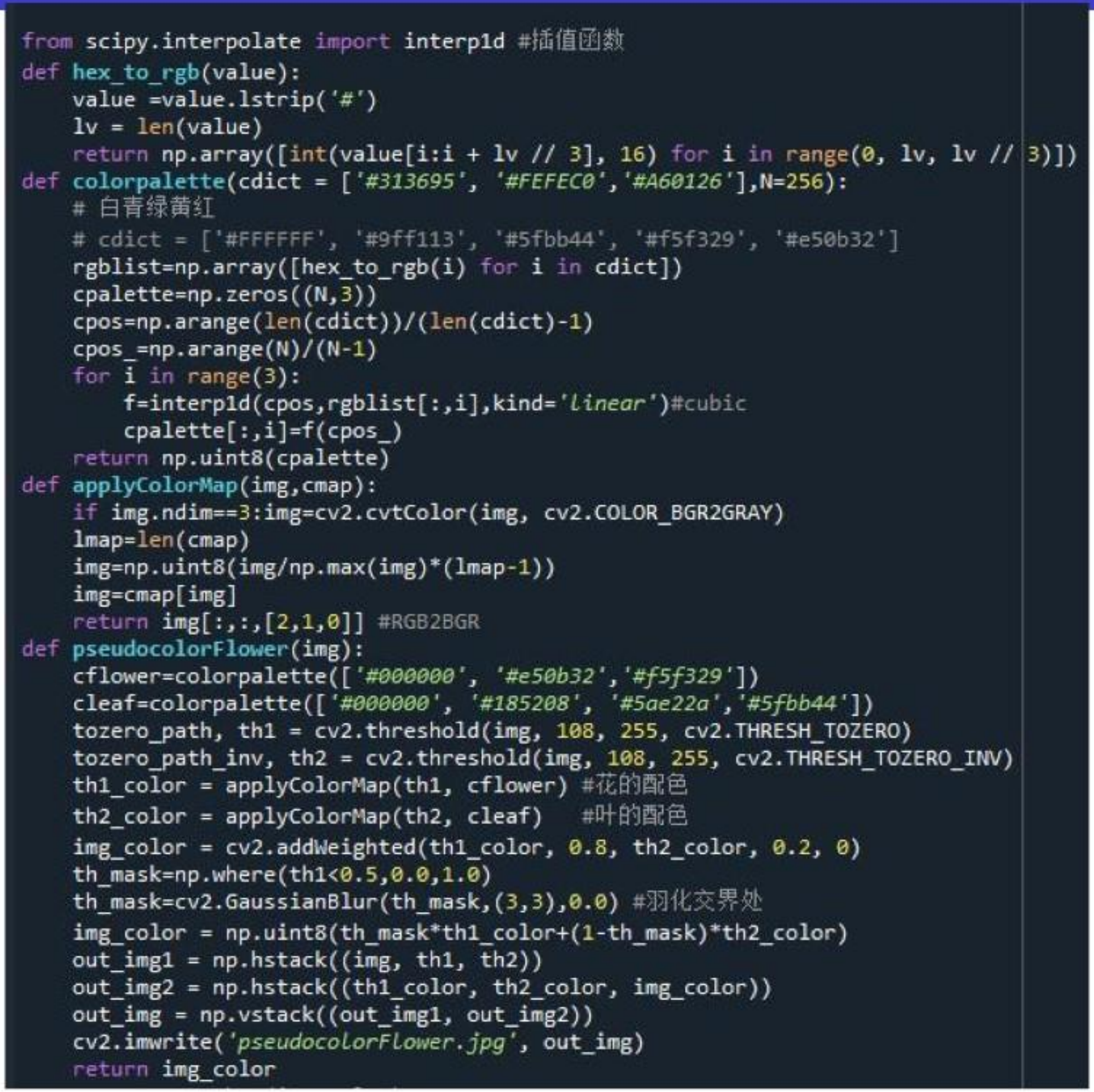
滤波前



滤波后

6 图像增强

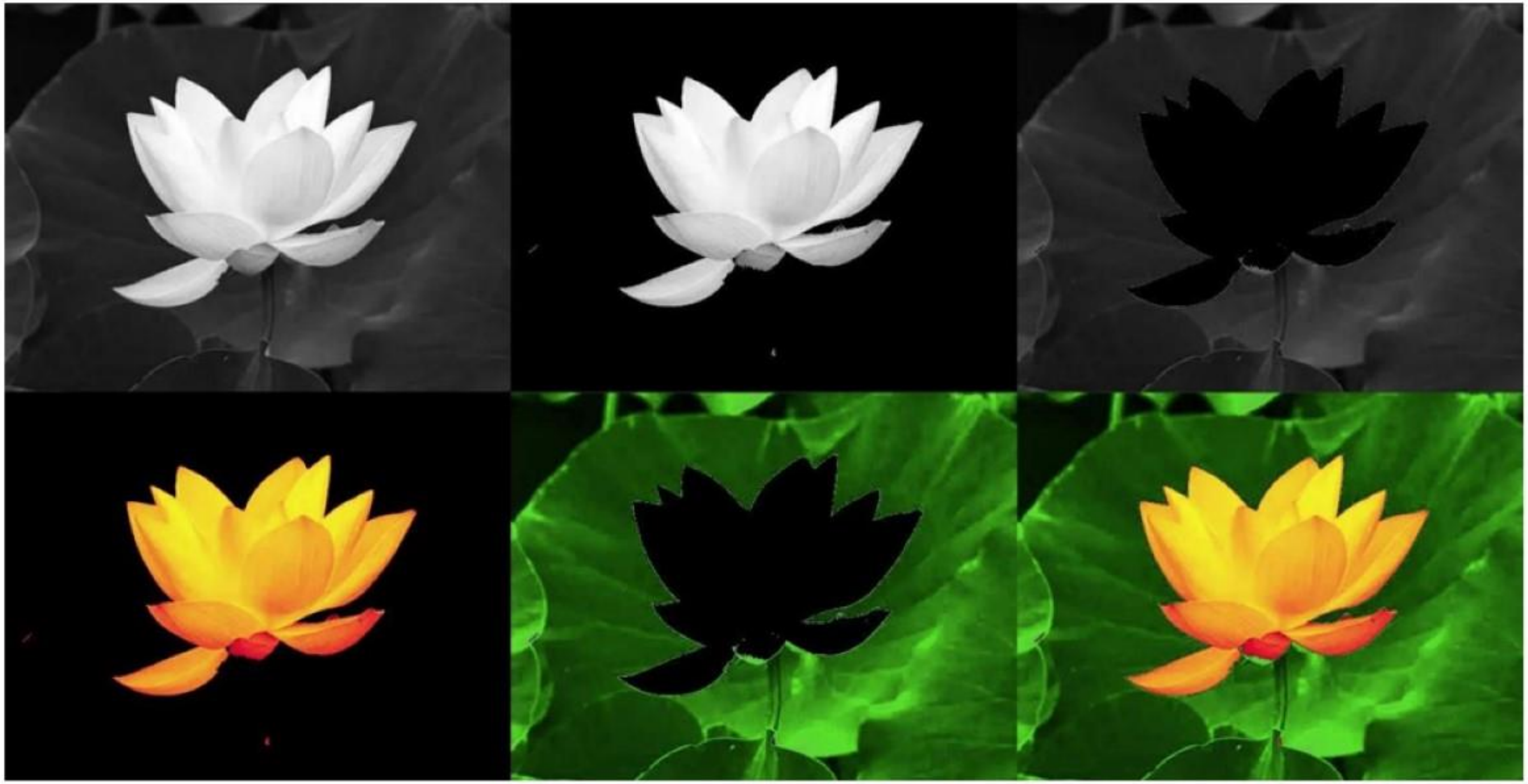
伪彩色着色



```
from scipy.interpolate import interp1d #插值函数
def hex_to_rgb(value):
    value =value.lstrip('#')
    lv = len(value)
    return np.array([int(value[i:i + lv // 3], 16) for i in range(0, lv, lv // 3)])
def colorpalette(cdict = ['#313695', '#FEFEC0','#A60126'],N=256):
    # 白青绿黄红
    # cdict = ['#FFFFFF', '#9ff113', '#5fbb44', '#f5f329', '#e50b32']
    rgblist=np.array([hex_to_rgb(i) for i in cdict])
    cpalette=np.zeros((N,3))
    cpos=np.arange(len(cdict))/(len(cdict)-1)
    cpos_=np.arange(N)/(N-1)
    for i in range(3):
        f=interp1d(cpos,rgblist[:,i],kind='linear')#cubic
        cpalette[:,i]=f(cpos_)
    return np.uint8(cpalette)
def applyColorMap(img,cmap):
    if img.ndim==3:img=cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    lmap=len(cmap)
    img=np.uint8(img/np.max(img)*(lmap-1))
    img=cmap[img]
    return img[:,:,[2,1,0]] #RGB2BGR
def pseudocolorFlower(img):
    cflower=colorpalette(['#000000', '#e50b32','#f5f329'])
    cleaf=colorpalette(['#000000', '#185208', '#5ae22a','#5fbb44'])
    tozero_path, th1 = cv2.threshold(img, 108, 255, cv2.THRESH_TOZERO)
    tozero_path_inv, th2 = cv2.threshold(img, 108, 255, cv2.THRESH_TOZERO_INV)
    th1_color = applyColorMap(th1, cflower) #花的配色
    th2_color = applyColorMap(th2, cleaf)   #叶的配色
    img_color = cv2.addWeighted(th1_color, 0.8, th2_color, 0.2, 0)
    th_mask=np.where(th1<0.5,0.0,1.0)
    th_mask=cv2.GaussianBlur(th_mask,(3,3),0.0) #羽化交界处
    img_color = np.uint8(th_mask*th1_color+(1-th_mask)*th2_color)
    out_img1 = np.hstack((img, th1, th2))
    out_img2 = np.hstack((th1_color, th2_color, img_color))
    out_img = np.vstack((out_img1, out_img2))
    cv2.imwrite('pseudocolorFlower.jpg', out_img)
    return img_color
```

6 图像增强

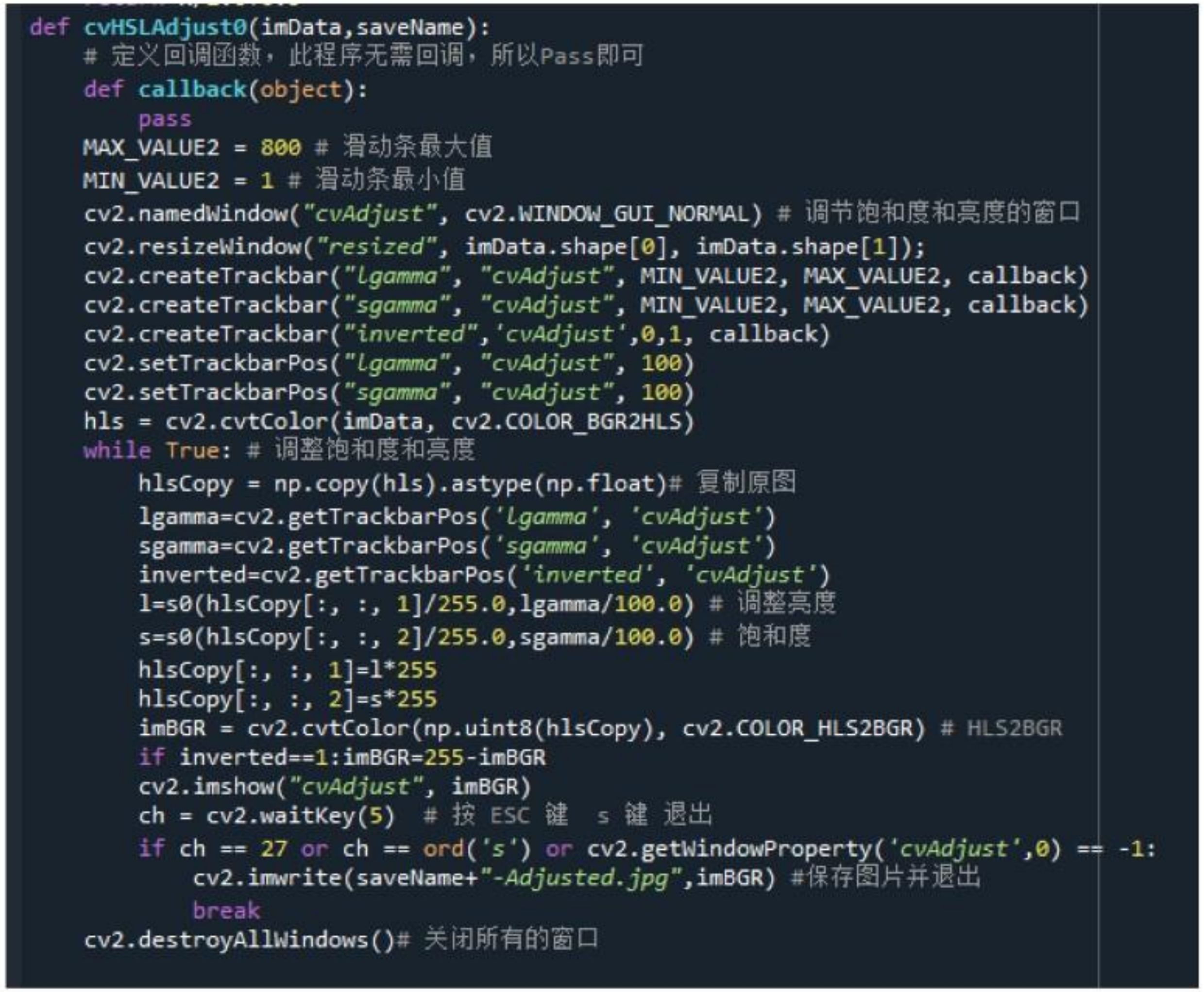
伪彩色着色



分割出花和叶，分别上色，最后合成

6 图像增强

颜色变换

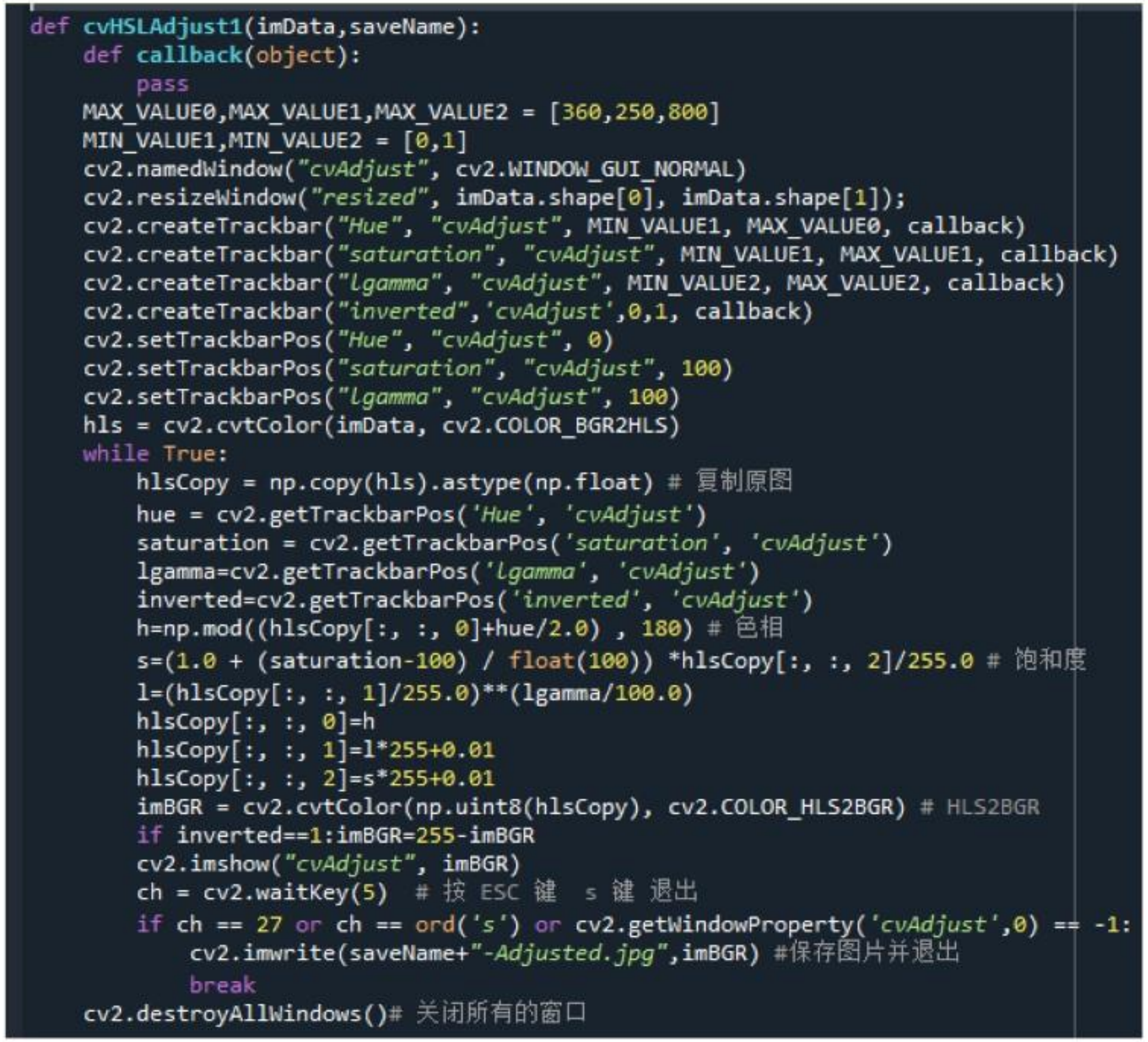


```python
def cvHSLAdjust0(imData,saveName):
    # 定义回调函数，此程序无需回调，所以Pass即可
    def callback(object):
        pass
    MAX_VALUE2 = 800 # 滑动条最大值
    MIN_VALUE2 = 1 # 滑动条最小值
    cv2.namedWindow("cvAdjust", cv2.WINDOW_GUI_NORMAL) # 调节饱和度和亮度的窗口
    cv2.resizeWindow("resized", imData.shape[0], imData.shape[1]);
    cv2.createTrackbar("lgamma", "cvAdjust", MIN_VALUE2, MAX_VALUE2, callback)
    cv2.createTrackbar("sgamma", "cvAdjust", MIN_VALUE2, MAX_VALUE2, callback)
    cv2.createTrackbar("inverted",'cvAdjust',0,1, callback)
    cv2.setTrackbarPos("lgamma", "cvAdjust", 100)
    cv2.setTrackbarPos("sgamma", "cvAdjust", 100)
    hls = cv2.cvtColor(imData, cv2.COLOR_BGR2HLS)
    while True: # 调整饱和度和亮度
        hlsCopy = np.copy(hls).astype(np.float)# 复制原图
        lgamma=cv2.getTrackbarPos('lgamma', 'cvAdjust')
        sgamma=cv2.getTrackbarPos('sgamma', 'cvAdjust')
        inverted=cv2.getTrackbarPos('inverted', 'cvAdjust')
        l=s0(hlsCopy[:, :, 1]/255.0,lgamma/100.0) # 调整亮度
        s=s0(hlsCopy[:, :, 2]/255.0,sgamma/100.0) # 饱和度
        hlsCopy[:, :, 1]=l*255
        hlsCopy[:, :, 2]=s*255
        imBGR = cv2.cvtColor(np.uint8(hlsCopy), cv2.COLOR_HLS2BGR) # HLS2BGR
        if inverted==1:imBGR=255-imBGR
        cv2.imshow("cvAdjust", imBGR)
        ch = cv2.waitKey(5)  # 按 ESC 键  s 键 退出
        if ch == 27 or ch == ord('s') or cv2.getWindowProperty('cvAdjust',0) == -1:
            cv2.imwrite(saveName+"-Adjusted.jpg",imBGR) #保存图片并退出
            break
    cv2.destroyAllWindows()# 关闭所有的窗口
```

在HSL空间操作，对SL两个通道做灰度变换调整对比度

6 图像增强

颜色变换



```
def cvHSLAdjust1(imData,saveName):
    def callback(object):
        pass
    MAX_VALUE0,MAX_VALUE1,MAX_VALUE2 = [360,250,800]
    MIN_VALUE1,MIN_VALUE2 = [0,1]
    cv2.namedWindow("cvAdjust", cv2.WINDOW_GUI_NORMAL)
    cv2.resizeWindow("resized", imData.shape[0], imData.shape[1]);
    cv2.createTrackbar("Hue", "cvAdjust", MIN_VALUE1, MAX_VALUE0, callback)
    cv2.createTrackbar("saturation", "cvAdjust", MIN_VALUE1, MAX_VALUE1, callback)
    cv2.createTrackbar("lgamma", "cvAdjust", MIN_VALUE2, MAX_VALUE2, callback)
    cv2.createTrackbar("inverted",'cvAdjust',0,1, callback)
    cv2.setTrackbarPos("Hue", "cvAdjust", 0)
    cv2.setTrackbarPos("saturation", "cvAdjust", 100)
    cv2.setTrackbarPos("lgamma", "cvAdjust", 100)
    hls = cv2.cvtColor(imData, cv2.COLOR_BGR2HLS)
    while True:
        hlsCopy = np.copy(hls).astype(np.float) # 复制原图
        hue = cv2.getTrackbarPos('Hue', 'cvAdjust')
        saturation = cv2.getTrackbarPos('saturation', 'cvAdjust')
        lgamma=cv2.getTrackbarPos('lgamma', 'cvAdjust')
        inverted=cv2.getTrackbarPos('inverted', 'cvAdjust')
        h=np.mod((hlsCopy[:, :, 0]+hue/2.0) , 180) # 色相
        s=(1.0 + (saturation-100) / float(100)) *hlsCopy[:, :, 2]/255.0 # 饱和度
        l=(hlsCopy[:, :, 1]/255.0)**(lgamma/100.0)
        hlsCopy[:, :, 0]=h
        hlsCopy[:, :, 1]=l*255+0.01
        hlsCopy[:, :, 2]=s*255+0.01
        imBGR = cv2.cvtColor(np.uint8(hlsCopy), cv2.COLOR_HLS2BGR) # HLS2BGR
        if inverted==1:imBGR=255-imBGR
        cv2.imshow("cvAdjust", imBGR)
        ch = cv2.waitKey(5)  # 按 ESC 鍵  s 鍵 退出
        if ch == 27 or ch == ord('s') or cv2.getWindowProperty('cvAdjust',0) == -1:
            cv2.imwrite(saveName+"-Adjusted.jpg",imBGR) #保存图片并退出
            break
    cv2.destroyAllWindows()# 关闭所有的窗口
```

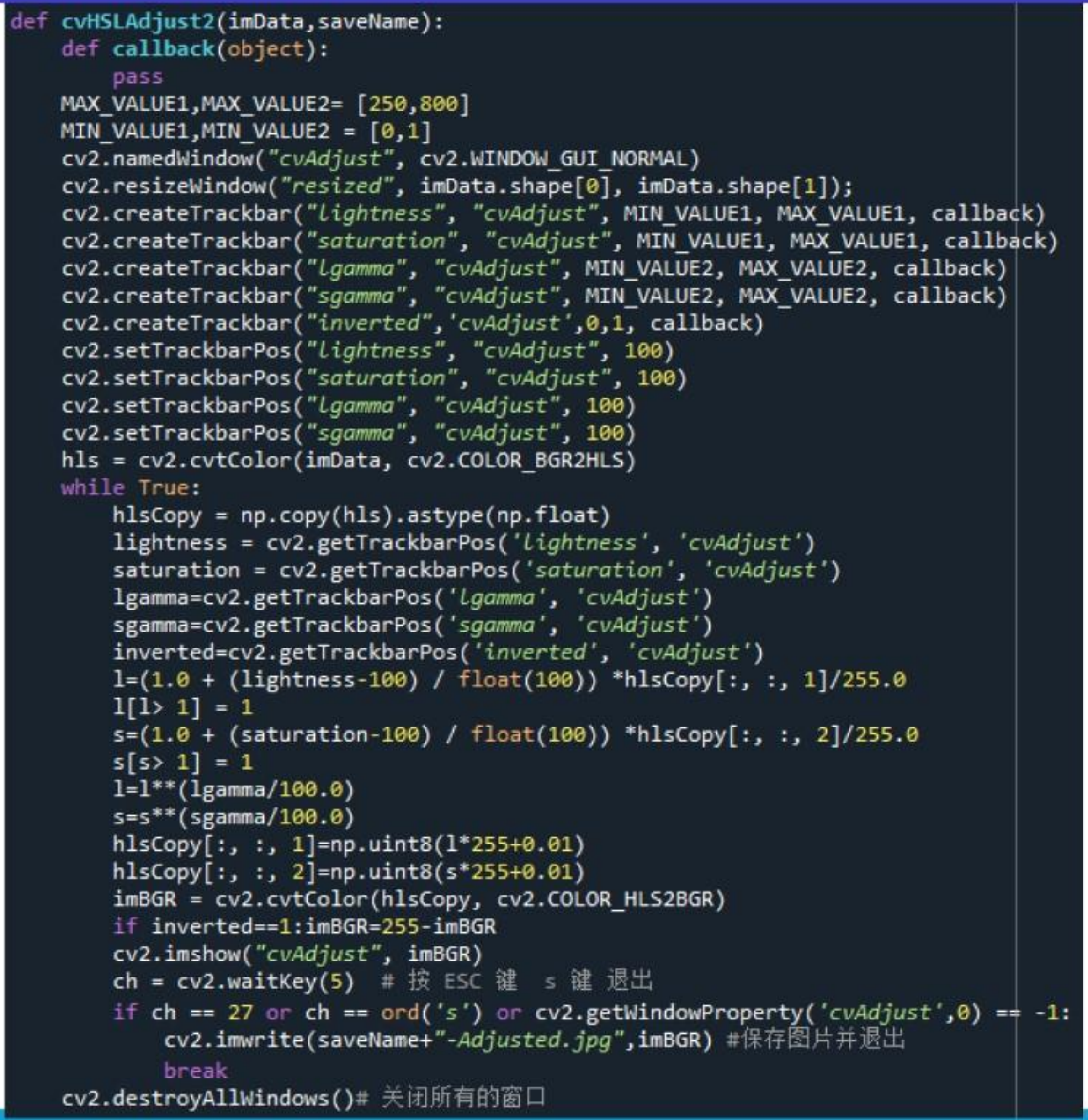
在HSL空间操作，SL通道自定义灰度变换，H通道平移色相

6 图像增强

颜色变换

在HSL空间操作，对SL通道做多次自定义灰度变换

- **灰度变换函数可自行设计**
- **调整变换次序对最终结果有影响**



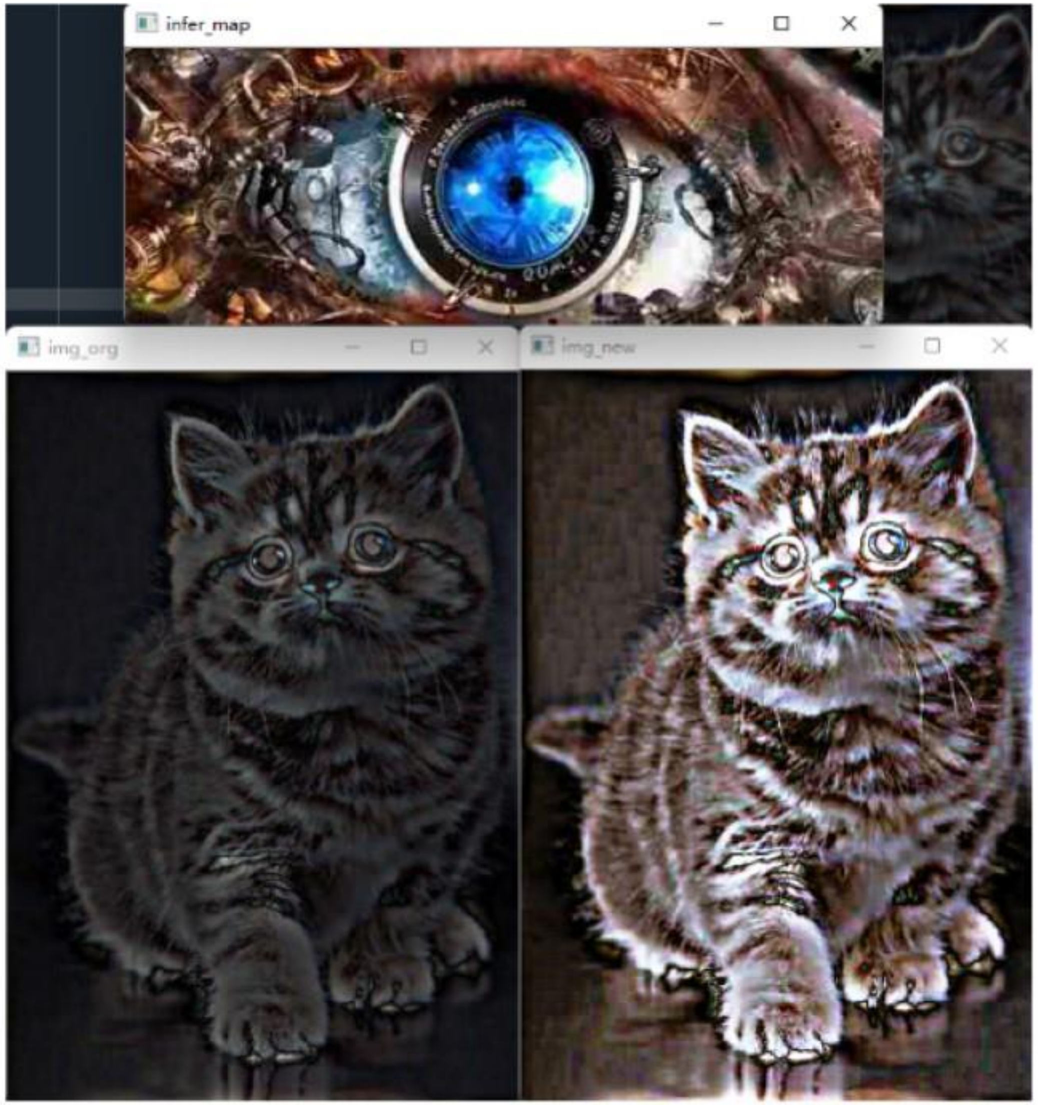
```
def cvHSLAdjust2(imData,saveName):
    def callback(object):
        pass
    MAX_VALUE1,MAX_VALUE2= [250,800]
    MIN_VALUE1,MIN_VALUE2 = [0,1]
    cv2.namedWindow("cvAdjust", cv2.WINDOW_GUI_NORMAL)
    cv2.resizeWindow("resized", imData.shape[0], imData.shape[1]);
    cv2.createTrackbar("lightness", "cvAdjust", MIN_VALUE1, MAX_VALUE1, callback)
    cv2.createTrackbar("saturation", "cvAdjust", MIN_VALUE1, MAX_VALUE1, callback)
    cv2.createTrackbar("lgamma", "cvAdjust", MIN_VALUE2, MAX_VALUE2, callback)
    cv2.createTrackbar("sgamma", "cvAdjust", MIN_VALUE2, MAX_VALUE2, callback)
    cv2.createTrackbar("inverted",'cvAdjust',0,1, callback)
    cv2.setTrackbarPos("lightness", "cvAdjust", 100)
    cv2.setTrackbarPos("saturation", "cvAdjust", 100)
    cv2.setTrackbarPos("lgamma", "cvAdjust", 100)
    cv2.setTrackbarPos("sgamma", "cvAdjust", 100)
    hls = cv2.cvtColor(imData, cv2.COLOR_BGR2HLS)
    while True:
        hlsCopy = np.copy(hls).astype(np.float)
        lightness = cv2.getTrackbarPos('lightness', 'cvAdjust')
        saturation = cv2.getTrackbarPos('saturation', 'cvAdjust')
        lgamma=cv2.getTrackbarPos('lgamma', 'cvAdjust')
        sgamma=cv2.getTrackbarPos('sgamma', 'cvAdjust')
        inverted=cv2.getTrackbarPos('inverted', 'cvAdjust')
        l=(1.0 + (lightness-100) / float(100)) *hlsCopy[:, :, 1]/255.0
        l[l> 1] = 1
        s=(1.0 + (saturation-100) / float(100)) *hlsCopy[:, :, 2]/255.0
        s[s> 1] = 1
        l=l**(lgamma/100.0)
        s=s**(sgamma/100.0)
        hlsCopy[:, :, 1]=np.uint8(l*255+0.01)
        hlsCopy[:, :, 2]=np.uint8(s*255+0.01)
        imBGR = cv2.cvtColor(hlsCopy, cv2.COLOR_HLS2BGR)
        if inverted==1:imBGR=255-imBGR
        cv2.imshow("cvAdjust", imBGR)
        ch = cv2.waitKey(5)  # 按 ESC 键  s 键 退出
        if ch == 27 or ch == ord('s') or cv2.getWindowProperty('cvAdjust',0) == -1:
            cv2.imwrite(saveName+"-Adjusted.jpg",imBGR) #保存图片并退出
            break
    cv2.destroyAllWindows()# 关闭所有的窗口
```

6 图像增强

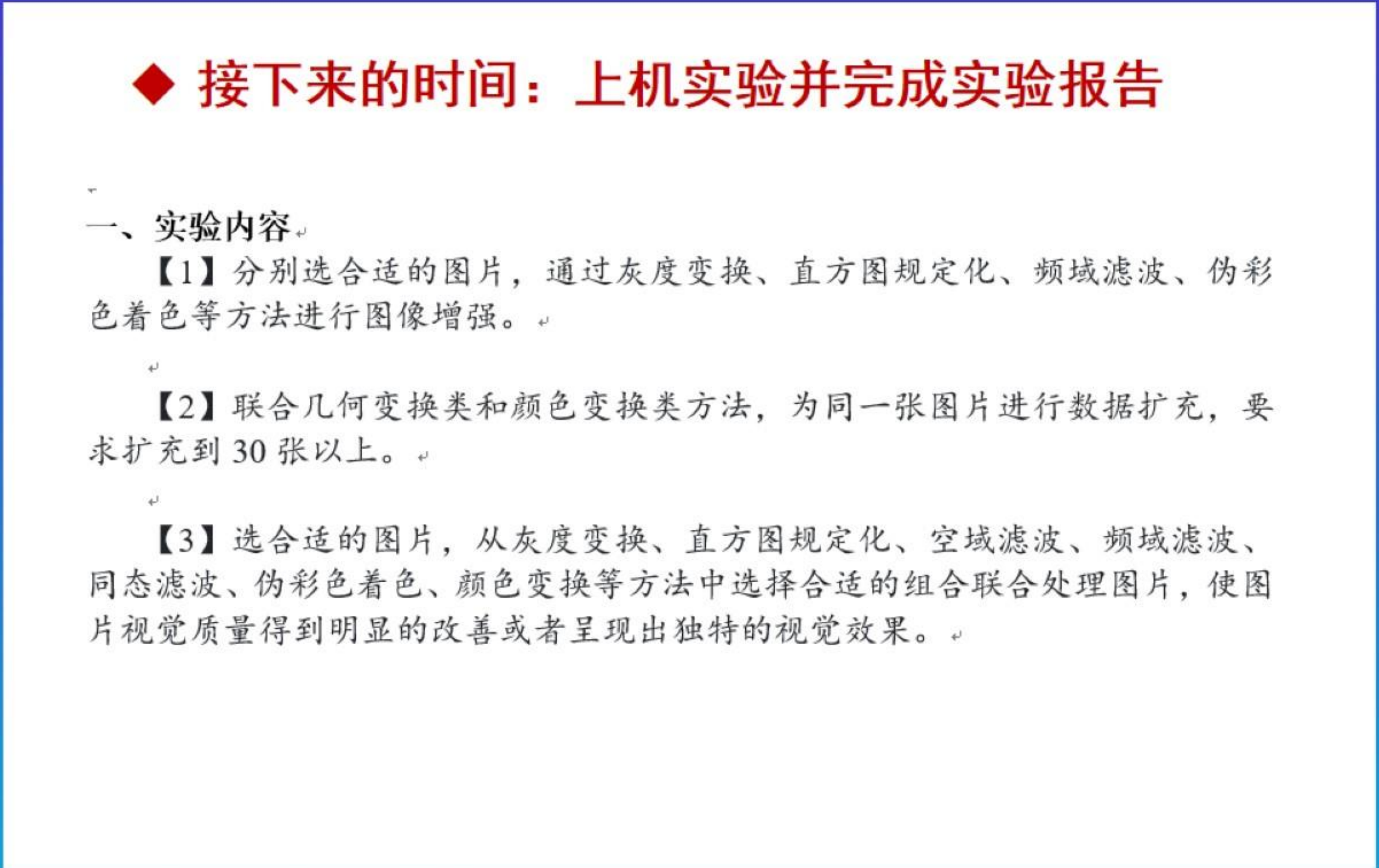
综合操作示例

高斯高频强调滤波+直方图规定化，后续还可增加其他增强处理

这只是简单示例，灵活运用各种图像增强手段，有无限的可能



6 图像增强



◆ 接下来的时间：上机实验并完成实验报告

一、实验内容

【1】分别选合适的图片，通过灰度变换、直方图规定化、频域滤波、伪彩色着色等方法进行图像增强。

【2】联合几何变换类和颜色变换类方法，为同一张图片进行数据扩充，要求扩充到30张以上。

【3】选合适的图片，从灰度变换、直方图规定化、空域滤波、频域滤波、同态滤波、伪彩色着色、颜色变换等方法中选择合适的组合联合处理图片，使图片视觉质量得到明显的改善或者呈现出独特的视觉效果。