

系统开发工具基础课程实验报告

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1 练习内容和结果

1.1 python基础

1.hello world

001helloworld.py里的内容是: print("Hello, Python!")

```
ouc@islouc-vm:~/vim/pack/vendor/start$ cd ~/Desktop/class/python_codes
ouc@islouc-vm:~/Desktop/class/python_codes$ touch 001helloworld.py
ouc@islouc-vm:~/Desktop/class/python_codes$ vim 001helloworld.py
Error detected while processing /home/ouc/.vimrc:
line 15:
E492: Not an editor command: 语法高亮
line 48:
E492: Not an editor command: 然后把它保存到 ~/.vimrc! Comments in Vimscript start with a `
Press ENTER or type command to continue
ouc@islouc-vm:~/Desktop/class/python_codes$ python3 001helloworld.py
Hello world
```

图 1: hello world

2.创建一个 Python 脚本进行变量定义和操作

```
1 integer_var = 42
2 float_var = 3.14
3 string_var = "Linux and Python"
4 boolean_var = True
5
6 print("Integer:", integer_var)
7 print("Float:", float_var)
8 print("String:", string_var)
9 print("Boolean:", boolean_var)
```

图 2: 创建python脚本variables.py进行变量定义和操作

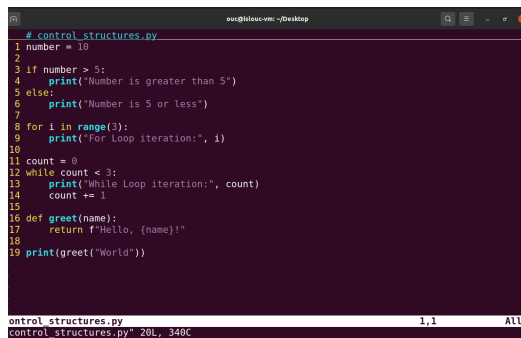
```
ouc@islouc-vm:~/Desktop$ nano variables.py
ouc@islouc-vm:~/Desktop$ python3 variables.py
Integer: 42
Float: 3.14
String: Linux and Python
Boolean: True
```

图 3: 运行脚本variables.py

3.掌握 Python 中的控制结构和函数定义。

4.学习如何定义和调用函数。

5.菱形



```
# control_structures.py
1 number = 10
2
3 if number > 5:
4     print("Number is greater than 5")
5 else:
6     print("Number is 5 or less")
7
8 for i in range(3):
9     print("For Loop iteration:", i)
10
11 count = 0
12 while count < 3:
13     print("While Loop iteration:", count)
14     count += 1
15
16 def greet(name):
17     return f"Hello, {name}!"
18
19 print(greet("World"))
```

图 4: 创建python脚本control_structures.py测试控制结构



```
ou@oulouc-vm: ~/Desktop$ name control_structures.py
ou@oulouc-vm: ~/Desktop$ vim control_structures.py
Error detected while processing /home/ouc/.vimrc:
line 15:
E492: Not an editor command: 语法高亮
line 48:
E492: Not an editor command: 然后把它保存到 ~/.vimrc! Comments in Vimscript start with a
".
Press ENTER or type command to continue
ou@oulouc-vm: ~/Desktop$ python3 control_structures.py
Number is greater than 5
For Loop iteration: 0
For Loop iteration: 1
For Loop iteration: 2
While Loop iteration: 0
While Loop iteration: 1
While Loop iteration: 2
Hello, World!
```

图 5: 执行control_structures.py脚本

6. 下面是一个示例 Python脚本loop.py，它演示了如何使用不同类型的循环（for 和 while）来处理基本的循环任务。这个脚本将打印从 1 到 5 的数字，并在 while 循环中计算数字的平方。

7.下面是一个简单的 Python 脚本，用于判断一个给定的年份是否为闰年

1.2 python视觉应用

1.PIL: Python 图像处理类库。

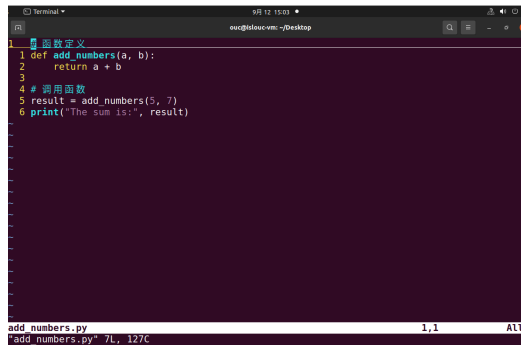
写个简单的Python程序，完成以下功能： a)打开一幅图片（如自己的照片）

b)将图片大小修改成640*480

c)将修改大小后的图像转成黑白图像

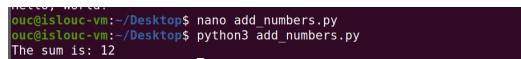
d)将黑白图像存成gif格式

实验图片路径为： imgs/exp1.1.jpg 输出路径为： outputs/ 请按照exp1.1.i的格式，输出四个结果，比如a)的结果保存为： outputs/exp1.1.1.jpg



```
1 # 函数定义
2 def add_numbers(a, b):
3     return a + b
4 # 调用函数
5 result = add_numbers(5, 7)
6 print("The sum is:", result)
```

图 6: 创建add_numbers.py脚本学习定义和调用函数



```
ouc@islouc-vm:~/Desktop$ nano add_numbers.py
ouc@islouc-vm:~/Desktop$ python3 add_numbers.py
The sum is: 12
```

图 7: 执行add_structures.py脚本

```
2.Matplotlib from PIL import Image
from pylab import *
import numpy as np
# 读取图像到数组中
im = np.array(Image.open('empire.jpg'))
# 绘制图像
imshow(im)
# 一些点
x = [100,100,400,400]
y = [200,500,200,500]
# 使用红色星状标记绘制点
plot(x,y,'r*')
# 绘制连接前两个点的线
plot(x[:2],y[:2])
# 添加标题，显示绘制的图像
title('Plotting: "empire.jpg"')
show()

3.Numpy
```

```
ouc@islouc-vm:~/Desktop$ nano diamond.py
ouc@islouc-vm:~/Desktop$ python3 diamond.py
*
***
*****
*****
*****
*****
*****
***
*
```

图 8: 输出菱形

```
GNU nano 4.8      loop.py
loop.py
def for_loop_example():
    """演示 for 循环"""
    print("For loop example:")
    for i in range(1, 6):
        print(f"Number: {i}")

def while_loop_example():
    """演示 while 循环"""
    print("\nWhile loop example:")
    i = 1
    while i <= 5:
        print(f"Number squared: {i**2}")
        i += 1

if __name__ == "__main__":
    for_loop_example()
    while_loop_example()
```

图 9: loop.py

4.1.imgs目录下有图像boardWithNoise.jpg，用Python写程序，采用自适应中值滤波器去除噪声干扰。

实验图片路径为： imgs/boardWithNoise.jpg

输出路径为： outputs/

请按照exp4_2.i的格式，输出每个任务结果

5.imgs目录下有图像windmill_noise.png，用Python写程序，去除条纹干扰。

实验图片路径为： imgs/windmill_noise.png

输出路径为： outputs/

请按照exp4_1.i的格式，输出每个任务结果

6.将Sobel算子编码到pytorch卷积核中，并用编码的卷积核对图像100_3228.jpg执行卷积操作，输出结果（水平梯度图像、垂直梯度图像和梯度幅值图像），理解卷积操作与空间域滤波的关系。

实验图片路径为： imgs/100_3228.jpg

输出路径为： outputs/

请按照exp2_3.i的格式，输出结果比如结果保存为： outputs/exp2_3-1.jpg

```

*
ouc@islouc-vm:~/Desktop$ nano loop.py
ouc@islouc-vm:~/Desktop$ python3 loop.py
For loop example:
Number: 1
Number: 2
Number: 3
Number: 4
Number: 5

While loop example:
Number squared: 1
Number squared: 4
Number squared: 9
Number squared: 16
Number squared: 25

```

图 10: 执行loop.py

```

GNU nano 4.8 leap_year.py
def is_leap_year(year):
    """判断是否是闰年"""
    if (year % 4 == 0 and year % 100 != 0) or (year % 400 == 0):
        return True
    else:
        return False

def main():
    """主函数"""
    year = int(input("请输入年份: "))
    if is_leap_year(year):
        print(f"{year} 是闰年。")
    else:
        print(f"{year} 不是闰年。")

if __name__ == "__main__":
    main()

```

图 11: leap_year.py

7.imgs目录下有图像laoshan.jpg，用Python写程序，将其作4阶haar小波变换，仅保留第四阶变换的系数，反变换，查看图像的结果。（Matlab代码已经给出，仅作参考）

实验图片路径为： imgs/laoshan.jpg

输出路径为： outputs/

请按照exp5_1.i的格式，输出每个任务结果

8.imgs目录下有图像1.jpg和2.jpg，用Python写程序，使用基于小波变换的方法将2.jpg中的人物融合到1.jpg中，提升融合效果。

实验图片路径为： imgs/1.jpg imgs/2.jpg

输出路径为： outputs/

请按照exp5_2.i的格式，输出每个任务结果

9.通过离散傅里叶变换我们可以得到频谱图，通过离散傅里叶逆变换我们可以将频谱图转换为原图，请使用pytorch实现离散傅里叶逆变换（可使用库函数或自定义函数），并将频谱图设置为初始值为高斯噪声的模型

```
ouc@islouc-vm:~/Desktop$ nano loop.py
ouc@islouc-vm:~/Desktop$ nano leap_year.py
ouc@islouc-vm:~/Desktop$ python3 leap_year.py
请输入年份: 2016
2016 是闰年。
```

图 12: 执行leap_year.py

```
1 from PIL import Image
2 image_1 = Image.open("imgs/exp1_1.jpg")
3 image_1.save("outputs/exp1_1_1.jpg")
4
5 image_2 = image_1.resize((640,480))
6 image_2.save("outputs/exp1_1_2.jpg")
7
8 image_3 = image_2.convert("L")
9 image_3.save("outputs/exp1_1_3.jpg")
10
11 image_3.save("outputs/exp1_1_4.gif")
```

图 13: PIL库运用实例

参数，利用逆变换的结果与原图之间的均方误差作为损失函数对模型参数进行优化，验证是否能够通过优化学习到频谱图。

实验图片路径为: imgs/2.JPG

输出路径为: outputs/

请按照exp3_3_i的格式，输出结果

10.墙纸分割实验

2 解题感悟

通过这次试验我了解了python基础知识和python计算机视觉相关知识，了解了如何在虚拟机中创建以及运行python脚本，了解了numpy、PIL、matplotlib、opencv等python库。此外还发现如果Tex course中图片太多时可以保存到Tex course里，无法粘贴也没事。

3 GitHub链接

<https://github.com/zyx-cyber/coursecontent.git>



图 14: a)输出结果



图 15: b)输出结果

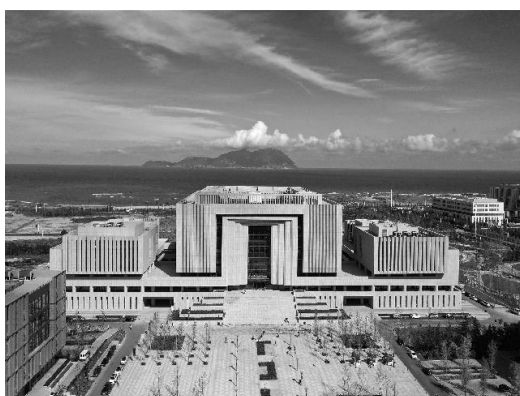


图 16: c)输出结果


```

ouc@islouc-vm: ~/Desktop$ nano matplotlib.py
ouc@islouc-vm:~/Desktop$ vim matplotlib.py
Error detected while processing /home/ouc/.vimrc:
line 15:
E492: Not an editor command: 语法高亮
line 48:
E492: Not an editor command: 然后把它保存到 ~/.vimrc! Comments in Vimscript start with a
Press ENTER or type command to continue
ouc@islouc-vm:~/Desktop$ python3 matplotlib.py
Traceback (most recent call last):
  File "matplotlib.py", line 2, in <module>
    pil_im = Image.open('empire.jpg')
  File "/usr/lib/python3/dist-packages/PIL/Image.py", line 2809, in open
    fp = builtins.open(filename, "rb")
FileNotFoundError: [Errno 2] No such file or directory: 'empire.jpg'

```

图 17: 运行matplotlib.py

```

GNU nano 4.8          numpy.py
from PIL import Image
from numpy import *
import numpy as np
im = np.array(Image.open('empire.jpg').convert('L'))
im2 = 255 - im # 对图像进行反相处理
im3 = (100.0/255) * im + 100 # 将图像像素值变换到 100...200 区间
im4 = 255.0 * (im/255.0)**2 # 对图像像素值取平方后得到的图像

```

图 18: numpy.py

```

ouc@islouc-vm:~/Desktop$ python3 numpy.py
Traceback (most recent call last):
  File "numpy.py", line 2, in <module>
    from numpy import *
  File "/home/ouc/Desktop/numpy.py", line 4, in <module>
    im = np.array(Image.open('empire.jpg').convert('L'))
AttributeError: partially initialized module 'numpy' has no attribute 'array' (most likely
due to a circular import)

```

图 19: 运行numpy.py

```

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

# 显示中文及设置坐标轴字体
plt.rcParams['font.sans-serif'] = ['SimHei']
plt.rcParams['axes.unicode_minus'] = False

def set_font_size(size=8):
    """设置坐标轴和图字体大小"""
    plt.xticks(fontsize=size)
    plt.yticks(fontsize=size)

def adaptive_median_filter(img, max_size=7, border_type=cv.BORDER_REFLECT):
    """自适应中值滤波算法"""
    rows, cols = img.shape
    denoised = np.zeros_like(img)
    padded = cv.copyMakeBorder(img, max_size, max_size, max_size, max_size, border_type)

    for i in range(rows):
        for j in range(cols):
            window = padded[i:i+2*max_size+1, j:j+2*max_size+1]
            denoised[i, j] = apply_filter(window, max_size, img[i, j])

    return denoised

def apply_filter(window, max_size, pixel):
    """滤波函数"""

```

图 20: 自适应中值滤波去噪上半部分

```

size = 3
median = np.median(window)
min_val, max_val = np.min(window), np.max(window)

if min_val < median < max_val:
    if min_val < pixel < max_val:
        return pixel
    else:
        return median
elif size <= max_size:
    padded = cv.copyMakeBorder(window, 1, 1, 1, 1, cv.BORDER_REFLECT)
    return apply_filter(padded, max_size, pixel)
else:
    return median

if __name__ == '__main__':
    img_noisy = cv.imread('imgs/boards11noise.jpg', 0) # 读取含噪灰度图
    img_denosed = adaptive_median_filter(img_noisy)
    img_median = cv.medianBlur(img_noisy, 7)

    plt.figure(figsize=(12, 4))
    plt.subplot(131), plt.imshow(img_noisy, 'gray'), plt.title('原始噪声图像'), set_font_size()
    plt.subplot(132), plt.imshow(img_denosed, 'gray'), plt.title('自适应中值滤波'), set_font_size()
    plt.subplot(133), plt.imshow(img_median, 'gray'), plt.title('标准中值滤波'), set_font_size()
    plt.tight_layout()
    plt.savefig('outputs/exp4_2_1.jpg', dpi=300, bbox_inches='tight')
    plt.show()

```

图 21: 自适应中值滤波去噪下半部分

```

import cv2
import numpy as np
# 读取图像
image_path = "imgs/windmill_noise.png"
output_path = "outputs/"
# 读取图像
img = cv2.imread(image_path, cv2.IMREAD_GRAYSCALE)
# 傅里叶变换
f = np.fft.fftf2(img)
fshift = np.fft.fftshift(f)
# 频谱图
magnitude_spectrum = 20 * np.log(np.abs(fshift))
# 去除条纹干扰
rows, cols = img.shape
crow, ccol = rows // 2, cols // 2
# 创建矩形窗口
mask = np.ones((rows, cols), np.uint8)
mask[crow-30:crow+30, ccol-30:ccol+30] = 0
# 应用掩码和逆傅里叶变换
fshift = fshift * mask
f_ishift = np.fft.ifftshift(fshift)
img_back = np.fft.ifft2(f_ishift)
img_back = np.abs(img_back)
# 反转颜色以增加对比度
img_back = 255 - img_back
# 保存结果
output_file = output_path + "exp4_1_1_windmill_noise_removed.png"
cv2.imwrite(output_file, img_back)

```

图 22: 去除条纹干扰

```

import torch.nn as nn
from PIL import Image
import numpy as np
import torchvision.transforms as transforms
from torch.autograd import Variable

# 加载图像
image_path = 'imgs/100_3228.jpg'
image = Image.open(image_path).convert('L') # 转换为灰度图像
transform = transforms.ToTensor()
image_tensor = transform(image)
image_tensor = image_tensor.unsqueeze(0) # 添加batch维度

# 定义Sobel算子的水平和垂直核
sobel_horizontal = np.array([[[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]], dtype=np.float32)
sobel_vertical = np.array([[[-1, -2, -1], [0, 0, 0], [1, 2, 1]], dtype=np.float32)

# 创建PyTorch卷积层
sobel_horizontal_conv = nn.Conv2d(1, 1, kernel_size=3, bias=False, padding=1)
sobel_vertical_conv = nn.Conv2d(1, 1, kernel_size=3, bias=False, padding=1)

# 设置卷积核权重
sobel_horizontal_conv.weight.data = torch.from_numpy(sobel_horizontal).view(1, 1, 3, 3)
sobel_vertical_conv.weight.data = torch.from_numpy(sobel_vertical).view(1, 1, 3, 3)

# 对图像应用水平和垂直Sobel滤波器
horizontal_gradient = sobel_horizontal_conv(Variable(image_tensor))
vertical_gradient = sobel_vertical_conv(Variable(image_tensor))

```

图 23: 卷积

```

import pywt
import numpy as np
from PIL import Image

# 读取图像并转换为灰度图
image_path = 'imgs/laoshan.jpg'
image = Image.open(image_path).convert('L')
image_array = np.array(image)

# 执行4级Haar小波变换
coeffs = pywt.wavedec2(image_array, 'haar', level=4)

# 仅使用最高层次的系数进行逆变换
coeffs[1:] = [tuple([np.zeros_like(v) for v in subband]) for subband in coeffs[1:]]
reconstructed_image_array = pywt.waverec2(coeffs, 'haar')

# 确保数据范围在0-255之间，并转换为uint8类型
reconstructed_image_array = np.clip(reconstructed_image_array, 0, 255).astype(np.uint8)

# 转换为图像并保存
output_path = 'outputs/exp5_1_1.jpg'
reconstructed_image = Image.fromarray(reconstructed_image_array)
reconstructed_image.save(output_path)

```

图 24: 小波变换

```

import numpy as np
import cv2 as cv

def fangcha(img):
    row, col = img.shape
    varImg = np.zeros((row, col))

    padded_img = np.pad(img, ((5, 5), (5, 5)), mode='reflect')

    for i in range(row):
        for j in range(col):
            window = padded_img[i:i+11, j:j+11]
            var = cv.meanStdDev(window)
            varImg[i, j] = var

    return varImg

def qiuquan(img1, img2):
    array1 = fangcha(img1)
    array2 = fangcha(img2)

    denom = array1 + array2
    weight1 = np.divide(array1, denom, out=np.zeros_like(array1), where=denom!=0)
    weight2 = np.divide(array2, denom, out=np.zeros_like(array2), where=denom!=0)

    return weight1, weight2

```

图 25: 小波变换上半部分

```

    return weight1, weight2

def ronghe(img1, img2):
    b, g, r = cv.split(img1)
    b1, g1, r1 = cv.split(img2)

    weight_b1, weight_b2 = qiuquan(b, b1)
    weight_g1, weight_g2 = qiuquan(g, g1)
    weight_r1, weight_r2 = qiuquan(r, r1)

    b_fused = (weight_b1 * b + weight_b2 * b1).astype(np.uint8)
    g_fused = (weight_g1 * g + weight_g2 * g1).astype(np.uint8)
    r_fused = (weight_r1 * r + weight_r2 * r1).astype(np.uint8)

    new_img = cv.merge([b_fused, g_fused, r_fused])
    return new_img

img1 = cv.imread("imgs/1.jpg")
img2 = cv.imread("imgs/2.jpg")
img3 = ronghe(img1, img2)
cv.imwrite("outputs/exp5_2_1.jpg", img3)

```

图 26: 小波变换下半部分

```

import torch
import torch.nn.functional as F
from PIL import Image
from torchvision import transforms

# 读取图片
image_path = "imgs/2.JPG"
output_path = "outputs/"
image = Image.open(image_path).convert('L') # 转换为灰度图
image.save(output_path + 'exp3_3_i_original.jpg')

# 转换为张量
transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Normalize(mean=[0.5], std=[0.5]) # 归一化到[-1, 1]
])
image_tensor = transform(image).unsqueeze(0) # 添加Batch维度

# 计算DFT
spectrum = torch.fft.fftshift(torch.fft.fft2(image_tensor))

# 初始化带有高斯噪声的频谱图
noise_std = 0.1 # 噪声标准差, 可根据需要调整
noisy_spectrum = spectrum + torch.randn_like(spectrum) * noise_std
torch.save(noisy_spectrum, output_path + 'exp3_3_i_noisy_spectrum.pt')

# 定义逆变换函数
def inverse_fft(noisy_spectrum):

```

图 27: 离散傅里叶逆变换上半部分

```

# 定义均方误差损失函数
def mse_loss(image1, image2):
    return F.mse_loss(image1, image2)

# 初始化优化器
optimizer = torch.optim.Adam([noisy_spectrum], lr=0.01)

# 迭代优化
num_iterations = 1000 # 迭代次数, 可根据需要调整
for i in range(num_iterations):
    # 使用逆傅里叶变换重建图像
    reconstructed_image = inverse_fft(noisy_spectrum)

    # 计算损失
    loss = mse_loss(reconstructed_image, image_tensor)

    # 反向传播和优化
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

    if (i + 1) % 100 == 0:
        print(f"Iteration {i + 1}/{num_iterations}, Loss: {loss.item()}")

# 保存结果
reconstructed_image = inverse_fft(noisy_spectrum)
image.fromarray((reconstructed_image.squeeze(0).numpy() * 255).astype('uint8')).save(output_path + 'exp3_3_i_reconstructed_image.jpg')

```

图 28: 离散傅里叶逆变换下半部分

```

import cv2
import numpy as np
from matplotlib import pyplot as plt
from skimage import exposure

# 定义函数进行图像处理
def process_image(image_path):
    # 读取并显示原图
    image = cv2.imread(image_path)
    image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    plt.figure(figsize=(10, 10))
    plt.imshow(image_rgb)
    plt.title('Original Image')
    plt.axis('off')
    plt.show()

    # 转换为灰度图像
    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    # 使用高斯模糊进行降噪处理
    gray = exposure.equalize_adapthist(gray, clip_limit=0.03)
    # 使用 Otsu 方法进行二值化
    ret, binary = cv2.threshold(gray * 255, 0, 255, cv2.THRESH_BINARY + cv2.THRESH_OTSU)

    # 显示二值化结果
    plt.figure(figsize=(10, 10))
    plt.imshow(binary, cmap='gray')
    plt.title('Binary Image')
    plt.axis('off')
    plt.show()

```

图 29: 墙纸分割实验上半部分

```

plt.title('Binary Image')
plt.axis('off')
plt.show()
# 找到轮廓
contours, hierarchy = cv2.findContours(binary, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
# 创建一个空白图像用于绘制前景
foreground = np.zeros_like(image_rgb)
# 绘制前景
cv2.drawContours(foreground, contours, -1, (255, 255, 255), thickness=cv2.FILLED)
# 显示前景图像
plt.figure(figsize=(10, 10))
plt.imshow(foreground)
plt.title('Foreground Image')
plt.axis('off')
plt.show()
return foreground
# 图像路径列表
image_paths = ['D:/wallpaper/wallpaper1.jpg', 'D:/wallpaper/wallpaper2.jpg', 'D:/wallpaper/wallpaper3.jpg', 'D:/wallpaper/wallpaper4.jpg', 'D:/wallpaper/wallpaper5.jpg']
# 循环处理并显示图像
for image_path in image_paths:
    processed_image = process_image(image_path)

```

图 30: 墙纸分割实验下半部分