# 实验报告

| | | |
|---|---|---|
| 课程名称 | ： | **数字图像处理** |
| 实验题目 | ： | **均值滤波、中值滤波的计算机实现** |
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**目录**



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# 1. 均值、中值滤波程序

本实验中我使用Python实现均值、中值滤波。对于图像的读取、处理和保存，我都使用了按字节进行读写的方式，符合实验要求。

BMP格式图片的读写已经写在实验二中，在此不再赘述。

## 1.1. 均值滤波

均值滤波就是将图片中某一像素点的值用该点和其周围九宫格内的八个点的均值来替代。这样可以有效滤去高斯噪声。

如果直接进行滤波，滤波结果尺寸将会缩减为$(originalHeight-2)\times(originalWidth-2)$。因此，需要先将原图像填充至$(originalHeight+2)\times(originalWidth+2)$，再进行滤波，滤波后的尺寸才能保持$originalHeight\times originalWidth$。

这里填充的内容选择重复原图片边缘的像素点。

代码实现如下：

```
    def meanfilter(self):
        self.meanfiltered_img = np.zeros_like(self.gray)
        padded_img = np.zeros((abs(self.biHeight) + 2, self.biWidth + 2),
dtype=np.int16)
        padded_img[1:-1, 1:-1] = self.gray
        padded_img[0, 1:-1] = self.gray[0, :]
        padded_img[-1, 1:-1] = self.gray[-1, :]
        padded_img[1:-1, 0] = self.gray[:, 0]
        padded_img[1:-1, -1] = self.gray[:, -1]
        padded_img[0][0] = self.gray[0][0]
        padded_img[0][-1] = self.gray[0][-1]
        padded_img[-1][0] = self.gray[-1][0]
        padded_img[-1][-1] = self.gray[-1][-1]
        for x in range(abs(self.biHeight)):
            for y in range(self.biWidth):
                self.meanfiltered_img[x][y] =
np.around(np.mean(padded_img[x:x+3, y:y+3]))
        return self.meanfiltered_img
```

## 1.2. 中值滤波

中值滤波就是将图片中某一像素点的值用该点和其周围九宫格内的八个点的中值来替代。这样可以有效滤去椒盐噪声。

填充的方法与均值滤波相同。

代码实现如下：

```
    def medianfilter(self):
        self.medianfiltered_img = np.zeros_like(self.gray)
        padded_img = np.zeros((abs(self.biHeight) + 2, self.biWidth + 2),
dtype=np.int16)
        padded_img[1:-1, 1:-1] = self.gray
        padded_img[0, 1:-1] = self.gray[0, :]
```

```
        padded_img[-1, 1:-1] = self.gray[-1, :]
        padded_img[1:-1, 0] = self.gray[:, 0]
        padded_img[1:-1, -1] = self.gray[:, -1]
        padded_img[0][0] = self.gray[0][0]
        padded_img[0][-1] = self.gray[0][-1]
        padded_img[-1][0] = self.gray[-1][0]
        padded_img[-1][-1] = self.gray[-1][-1]
        for x in range(abs(self.biHeight)):
            for y in range(self.biWidth):
                self.medianfiltered_img[x][y] =
np.around(np.median(padded_img[x:x+3, y:y+3]))
        return self.medianfiltered_img
```

## 1.3. GUI界面设计和程序逻辑

由于相比实验二多了两个功能，UI界面和控件函数需要新增和修改。

新增和修改的代码如下：

```
def medianfilter():
    if path_ == '':
        return
    image = BmpData(path_)
    medianfiltered_img = image.medianfilter()
    medianfiltered_img =
Image.fromarray(medianfiltered_img.astype(np.uint8))
    # medianfiltered_img.show()

    name_parts = path_.split('.')
    name_parts[-2] += "_medianfiltered"
    new_file_name = '.'.join(name_parts)
    image.save_medianfiltered_img(new_file_name)

    medianfiltered_img = medianfiltered_img.resize((int(256 * 0.8), int(256
* 0.8)))
    medianfiltered_img = ImageTk.PhotoImage(medianfiltered_img)
    label_image2.config(image=medianfiltered_img)
    label_image2.image = medianfiltered_img  # 处理后的图片的显示



def meanfilter():
    if path_ == '':
        return
    image = BmpData(path_)
    meanfiltered_img = image.meanfilter()
    meanfiltered_img = Image.fromarray(meanfiltered_img.astype(np.uint8))
    # meanfiltered_img.show()

    name_parts = path_.split('.')
    name_parts[-2] += "_meanfiltered"
    new_file_name = '.'.join(name_parts)
    image.save_meanfiltered_img(new_file_name)

```

```
    meanfiltered_img = meanfiltered_img.resize((int(256 * 0.8), int(256 * 0.8)))
    meanfiltered_img = ImageTk.PhotoImage(meanfiltered_img)
    label_image2.config(image=meanfiltered_img)
    label_image2.image = meanfiltered_img  # 处理后的图片的显示


if __name__ == "__main__":
    root = tkinter.Tk()
    root.title('21281280柯劲帆')  # 标题
    width, height = 600, 400
    width_max, height_max = root.maxsize()
    s_center = '%dx%d+%d+%d' % (width, height, (width_max - width) / 2, (height_max - height) / 2)  # 将页面显示在正中间
    root.geometry(s_center)
    root.resizable(width=False, height=False)  # 窗口不可移动
    l = tkinter.Label(root, text='实验三', width=60, height=2, fg='black', font=("微软雅黑", 16), anchor=tkinter.CENTER)
    l.pack()

    label_image1 = tkinter.Label(root, width=int(256 * 0.8), height=int(256 * 0.8), bg='whitesmoke', anchor=tkinter.NE)
    label_image1.pack()
    label_image1.place(x=45, y=70, width=int(256 * 0.8), height=int(256 * 0.8))

    label_image2 = tkinter.Label(root, width=int(256 * 0.8), height=int(256 * 0.8), bg='whitesmoke', anchor=tkinter.NE)
    label_image2.place(x=350, y=70, width=int(256 * 0.8), height=int(256 * 0.8))

    # 文本按钮
    Image_Input = tkinter.Button(root, text='Choose', command=choosepic)
    Image_Input.place(x=50, y=300, width=90, height=30)

    # 直方图均衡化
    Fun1 = tkinter.Button(root, text='直方图均衡化', command=equalize)
    Fun1.place(x=150, y=300, width=90, height=30)

    # 中值滤波
    Fun1 = tkinter.Button(root, text='中值滤波', command=medianfilter)  # 添加对应按钮
    Fun1.place(x=250, y=300, width=90, height=30)

    # 均值滤波
    Fun2 = tkinter.Button(root, text='均值滤波', command=meanfilter)  # 添加对应按钮
    Fun2.place(x=350, y=300, width=90, height=30)

    # 退出
    Quit = tkinter.Button(root, text='Quit', command=sys.exit)
    Quit.place(x=450, y=300, width=90, height=30)

    end = tkinter.Label(root, text='21281280 柯劲帆', fg='silver', font=("微软雅黑", 10))
    end.place(x=215, y=360, width=200, height=20)
```

```
80      root.mainloop()
```

# 2. 实验过程

编好代码后，对Python代码进行封装，变成exe可执行程序。

在命令行中配置环境并封装：

```
> pip install pyinstaller
> Pyinstaller -F -w read_bmp.py
```

在文件资源管理器窗口中双击exe文件，即可运行。

# 3. 实验结果及分析

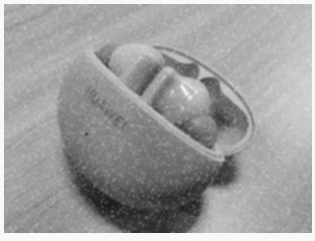
这里我准备了手机拍摄的1张图片，对其添加高斯噪声和椒盐噪声：

```
import skimage
from PIL import Image
import numpy as np

if __name__ == '__main__':
    origin =
skimage.img_as_float(Image.open('./test_images/my_image_normal.bmp'))
    noisy = skimage.util.random_noise(origin, mode='gaussian', var=0.01)
    noisy = (noisy * 255).astype(np.uint8)
    skimage.io.imsave('./test_images/my_image_gaussiannoise.bmp', noisy)

    origin =
skimage.img_as_float(Image.open('./test_images/my_image_normal.bmp'))
    noisy = skimage.util.random_noise(origin, mode='salt')
    noisy = (noisy * 255).astype(np.uint8)
    skimage.io.imsave('./test_images/my_image_saltnoise.bmp', noisy)
```

进行中值滤波、均值滤波过程和结果如下：

| | 正常 | 加高斯噪声 | 加椒盐噪声 |
|---|---|---|---|
| 原图 |  |  |  |
| 中值滤波结果 |  |  |  |
| 均值滤波结果 |  |  |  |
| 中值滤波过程 |  |  |  |

| | | | |
|---|---|---|---|
| 均值滤波过程 |  |  |  |

可见正常的图进行中值滤波后，细节有所丢失，蓝色斑点几乎消失；进行均值滤波后，蓝色斑点有所保留；

加了高斯噪声的图进行中值滤波和均值滤波的效果都并不好，还是很模糊；

加了椒盐噪声的图进行中值滤波后，噪声能明显去除；进行均值滤波，噪声去除效果不佳。

# 4. 心得体会

通过本次实验，我掌握了图像的均值滤波和中值滤波的原理及实现方法。

均值滤波可以有效滤除图像中的高斯噪声，它通过用像素点周围区域的平均值来替代该像素点的值，由于高斯噪声具有零均值的特点，所以能够有效地减弱噪声；中值滤波可以有效去除图像中的椒盐噪声，它通过用像素点周围区域的中值来替代该像素点的值，由于椒盐噪声往往处于区域灰度值的两端，使用中值可以将其排除在外。

通过测试不同的图像，我观察到均值滤波对正常图像会造成一定的模糊，而中值滤波可以很好地保持边缘细节。所以在不需要强烈平滑图像的情况下，中值滤波更好。当图像包含不同类型的噪声时，需要权衡使用均值滤波还是中值滤波。

通过本次实验，我对数字图像处理滤波方法有了更深入的理解。

# 5. 源代码

```
import numpy as np
from struct import unpack
from PIL import Image, ImageTk
import sys
import tkinter
import tkinter.filedialog

class BmpData:
    def __init__(self, file_path:str):
        with open(file_path, "rb") as file:
            self.file = file

            self.bfType = unpack("<H", file.read(2))[0] # 0x00 文件类型
            self.bfSize = unpack("<i", file.read(4))[0] # 0x02 文件大小
            self.bfReserved1 = unpack("<H", file.read(2))[0]    # 0x06 保留，必须设置为0
            self.bfReserved2 = unpack("<H", file.read(2))[0]    # 0x08 保留，必须设置为0
            self.bfOffBits = unpack("<i", file.read(4))[0]  # 0x0a 从头到位图数据的偏移
            self.biSize = unpack("<i", file.read(4))[0] # 0x0e 信息头的大小
            self.biWidth = unpack("<i", file.read(4))[0]    # 0x12 图像的宽度(以像素为单位)
            self.biHeight = unpack("<i", file.read(4))[0]   # 0x16 图像的高度(以像素为单位)(负说明图像是倒立的)
            self.biPlanes = unpack("<H", file.read(2))[0]   # 0x1a 颜色平面数
            self.biBitCount = unpack("<H", file.read(2))[0] # 0x1c 比特数/像素数
            self.biCompression = unpack("<i", file.read(4))[0]  # 0x1e 压缩类型
            self.biSizeImage = unpack("<i", file.read(4))[0]    # 0x22 位图数据的大小
            self.biXPelsPerMeter = unpack("<i", file.read(4))[0]    # 0x26 水平分辨率
            self.biYPelsPerMeter = unpack("<i", file.read(4))[0]    # 0x2a 垂直分辨率
            self.biClrUsed = unpack("<i", file.read(4))[0]  # 0x2e 位图使用的调色板中的颜色索引数
            self.biClrImportant = unpack("<i", file.read(4))[0] # 0x32 对图像显示有重要影响的颜色索引数(0说明都重要)

            self.color_palette = self.get_color_palette()
            self.img_np = self.get_numpy_img()
            self.gray = self.get_gray_img()
            file.close()

    def get_color_palette(self) -> np.ndarray:
        if (self.bfOffBits == 0x36):  # 16/24位图像不需要调色板，起始位置就等于0x36
            return None
        color_alette_size = 2 ** int(self.biBitCount) # 多少字节调色板颜色就有2^n个
```

```
        color_palette = np.zeros((color_alette_size, 3), dtype=np.int32)
        self.file.seek(0x36)
        for i in range(color_alette_size):
            b = unpack("B", self.file.read(1))[0]
            g = unpack("B", self.file.read(1))[0]
            r = unpack("B", self.file.read(1))[0]
            alpha = unpack("B", self.file.read(1))[0]
            color_palette[i][0] = b
            color_palette[i][1] = g
            color_palette[i][2] = r
        return color_palette

    def get_numpy_img(self) -> np.ndarray:
        biHeight = abs(self.biHeight)
        img_np = np.zeros((biHeight, self.biWidth, 3), dtype=np.int32)
        self.file.seek(self.bfOffBits)
        for x in range(biHeight):
            row_byte_count = ((self.biWidth * self.biBitCount + 31) >> 5)
<< 2
            row_bits = self.file.read(row_byte_count)
            row_bits = ''.join(format(byte, '08b') for byte in row_bits)
            for y in range(self.biWidth):
                pixel_data = row_bits[y * self.biBitCount: (y + 1) *
self.biBitCount]
                if self.biHeight > 0:   # 图像倒立
                    img_np[biHeight - 1 - x][y] = self.get_RGB(pixel_data)
                else:
                    img_np[x][y] = self.get_RGB(pixel_data)
        return img_np

    def get_gray_img(self) -> np.ndarray:
        biHeight = abs(self.biHeight)
        gray_img = np.dot(self.img_np.reshape((biHeight * self.biWidth,
3)).astype(np.float32),
                          [0.299, 0.587, 0.114]).astype(np.int32)
        gray_img = gray_img.reshape((biHeight, self.biWidth))
        return gray_img

    def get_RGB(self, pixel_data:str):
        if len(pixel_data) <= 8:
            color_index = int(pixel_data, 2)
            return self.color_palette[color_index]
        elif len(pixel_data) == 16:
            b = int(pixel_data[1:6], 2) * 8
            g = int(pixel_data[6:11], 2) * 8
            r = int(pixel_data[11:16], 2) * 8
            return [r, g, b]
        elif len(pixel_data) == 24:
            b = int(pixel_data[0:8], 2)
            g = int(pixel_data[8:16], 2)
            r = int(pixel_data[16:24], 2)
            return [r, g, b]
        elif len(pixel_data) == 32:
            b = int(pixel_data[0:8], 2)
            g = int(pixel_data[8:16], 2)
            r = int(pixel_data[16:24], 2)
```

```
            alpha = int(pixel_data[24:32], 2)
            return [r, g, b]


    def equalize(self, level:int):
        biHeight = abs(self.biHeight)
        self.hist = np.zeros(256, dtype=np.int32)
        max_value = self.gray.max()
        min_value = self.gray.min()
        gap = (max_value - min_value + 1) / level
        for x in range(biHeight):
            for y in range(self.biWidth):
                self.hist[self.gray[x, y]] += 1
        hist = np.zeros(level, dtype=np.float32)
        for i in range(level):
            hist[i] = np.sum(self.hist[min_value + int(i * gap) : min_value
+ int((i + 1) * gap)])
        hist /= biHeight * self.biWidth
        for i in range(1, level):
            hist[i] += hist[i - 1]
        hist *= level
        hist = np.around(hist)
        hist /= level
        hist = np.floor(hist * 255).astype(np.int32)
        self.equalized_img = np.zeros_like(self.gray)
        self.equalized_hist = np.zeros(256, dtype=np.int32)
        for x in range(biHeight):
            for y in range(self.biWidth):
                self.equalized_img[x, y] = hist[int((self.gray[x, y] -
min_value) / gap)]
                self.equalized_hist[self.equalized_img[x, y]] += 1
        return self.equalized_img, self.hist, self.equalized_hist


    def save_equalized_img(self, save_path:str):
        self.save_img(image=self.equalized_img, save_path=save_path)


    def medianfilter(self):
        self.medianfiltered_img = np.zeros_like(self.gray)
        padded_img = np.zeros((abs(self.biHeight) + 2, self.biWidth + 2),
dtype=np.int16)
        padded_img[1:-1, 1:-1] = self.gray
        padded_img[0, 1:-1] = self.gray[0, :]
        padded_img[-1, 1:-1] = self.gray[-1, :]
        padded_img[1:-1, 0] = self.gray[:, 0]
        padded_img[1:-1, -1] = self.gray[:, -1]
        padded_img[0][0] = self.gray[0][0]
        padded_img[0][-1] = self.gray[0][-1]
        padded_img[-1][0] = self.gray[-1][0]
        padded_img[-1][-1] = self.gray[-1][-1]
        for x in range(abs(self.biHeight)):
            for y in range(self.biWidth):
                self.medianfiltered_img[x][y] =
np.around(np.median(padded_img[x:x+3, y:y+3]))
        return self.medianfiltered_img
```

```
144
145
146     def save_medianfiltered_img(self, save_path:str):
147         self.save_img(image=self.medianfiltered_img, save_path=save_path)
148
149
150     def meanfilter(self):
151         self.meanfiltered_img = np.zeros_like(self.gray)
152         padded_img = np.zeros((abs(self.biHeight) + 2, self.biWidth + 2),
    dtype=np.int16)
153         padded_img[1:-1, 1:-1] = self.gray
154         padded_img[0, 1:-1] = self.gray[0, :]
155         padded_img[-1, 1:-1] = self.gray[-1, :]
156         padded_img[1:-1, 0] = self.gray[:, 0]
157         padded_img[1:-1, -1] = self.gray[:, -1]
158         padded_img[0][0] = self.gray[0][0]
159         padded_img[0][-1] = self.gray[0][-1]
160         padded_img[-1][0] = self.gray[-1][0]
161         padded_img[-1][-1] = self.gray[-1][-1]
162         for x in range(abs(self.biHeight)):
163             for y in range(self.biWidth):
164                 self.meanfiltered_img[x][y] =
    np.around(np.mean(padded_img[x:x+3, y:y+3]))
165         return self.meanfiltered_img
166
167
168     def save_meanfiltered_img(self, save_path:str):
169         self.save_img(image=self.meanfiltered_img, save_path=save_path)
170
171
172     def save_img(self, image:np.ndarray, save_path:str):
173         with open(save_path, "wb") as file:
174             file.write(int(self.bfType).to_bytes(2, byteorder='little'))
     # 0x00 文件类型
175             file.write(int(0x36 + 0x100 * 4 + self.biWidth *
    abs(self.biHeight)).to_bytes(4, byteorder='little'))   # 0x02 文件大小
176             file.write(int(0).to_bytes(4, byteorder='little'))  # 0x06 保
    留，必须设置为0
177             file.write(int(0x36 + 0x100 * 4).to_bytes(4,
    byteorder='little')) # 0x0a 从头到位图数据的偏移
178             file.write(int(40).to_bytes(4, byteorder='little')) # 0x0e 信息
    头的大小
179             file.write(int(self.biWidth).to_bytes(4, byteorder='little'))
    # 0x12 图像的宽度
180             file.write(int(self.biHeight).to_bytes(4, byteorder='little'))
     # 0x16 图像的高度
181             file.write(int(self.biPlanes).to_bytes(2, byteorder='little'))
     # 0x1a 颜色平面数
182             file.write(int(8).to_bytes(2, byteorder='little'))    # 0x1c 比
    特数/像素数
183             file.write(int(self.biCompression).to_bytes(4,
    byteorder='little')) # 0x1e 压缩类型
184             file.write(int(self.biSizeImage).to_bytes(4,
    byteorder='little'))   # 0x22 位图数据的大小
185             file.write(int(self.biXPelsPerMeter).to_bytes(4,
    byteorder='little'))   # 0x26 水平分辨率
```

```
            file.write(int(self.biYPelsPerMeter).to_bytes(4, byteorder='little'))   # 0x2a 垂直分辨率
            file.write(int(0x100 * 4).to_bytes(4, byteorder='little'))  # 0x2e 位图使用的调色板中的颜色索引数
            file.write(int(0).to_bytes(4, byteorder='little'))  # 0x32 对图像显示有重要影响的颜色索引数

            for i in range(256):
                file.write(int(i).to_bytes(1, byteorder='little'))
                file.write(int(i).to_bytes(1, byteorder='little'))
                file.write(int(i).to_bytes(1, byteorder='little'))
                file.write(int(0).to_bytes(1, byteorder='little'))

            for x in range(abs(self.biHeight)):
                for y in range(self.biWidth):
                    if self.biHeight > 0:
                        file.write(int(image[self.biHeight - 1 - x][y]).to_bytes(1, byteorder='little'))
                    else:
                        file.write(int(image[x][y]).to_bytes(1, byteorder='little'))
                file.write(b'0' * ((((self.biWidth * 8 + 31) >> 5) << 2) - 8 * self.biWidth))

            file.close()


def choosepic():
    global path_
    path_ = tkinter.filedialog.askopenfilename(title='请选择图片文件', filetypes=[('图片', '.bmp')])
    if path_ == '':
        return
    img_temp = Image.open(path_).resize((int(256 * 0.8), int(256 * 0.8)))  # 图片读取和加载
    img = ImageTk.PhotoImage(img_temp)
    label_image1.config(image=img)
    label_image1.image = img


def equalize():
    if path_ == '':
        return
    image = BmpData(path_)
    # img = Image.fromarray(image.img_np.astype(np.uint8))
    # img.show()

    equalized_img, hist, equalized_hist = image.equalize(8)  # 分别为均衡化的图/直方图/均衡化后的直方图
    equalized_img = Image.fromarray(equalized_img.astype(np.uint8))
    # equalized_img.show()

    name_parts = path_.split('.')
    name_parts[-2] += "_equalized"
    new_file_name = '.'.join(name_parts)
    image.save_equalized_img(new_file_name)
```

```
233
234     equalized_img = equalized_img.resize((int(256 * 0.8), int(256 * 0.8)))
235     equalized_img = ImageTk.PhotoImage(equalized_img)
236     label_image2.config(image=equalized_img)
237     label_image2.image = equalized_img  # 处理后的图片的显示
238
239
240 def medianfilter():
241     if path_ == '':
242         return
243     image = BmpData(path_)
244     medianfiltered_img = image.medianfilter()
245     medianfiltered_img =
Image.fromarray(medianfiltered_img.astype(np.uint8))
246     # medianfiltered_img.show()
247
248     name_parts = path_.split('.')
249     name_parts[-2] += "_medianfiltered"
250     new_file_name = '.'.join(name_parts)
251     image.save_medianfiltered_img(new_file_name)
252
253     medianfiltered_img = medianfiltered_img.resize((int(256 * 0.8), int(256
* 0.8)))
254     medianfiltered_img = ImageTk.PhotoImage(medianfiltered_img)
255     label_image2.config(image=medianfiltered_img)
256     label_image2.image = medianfiltered_img  # 处理后的图片的显示
257
258
259
260 def meanfilter():
261     if path_ == '':
262         return
263     image = BmpData(path_)
264     meanfiltered_img = image.meanfilter()
265     meanfiltered_img = Image.fromarray(meanfiltered_img.astype(np.uint8))
266     # meanfiltered_img.show()
267
268     name_parts = path_.split('.')
269     name_parts[-2] += "_meanfiltered"
270     new_file_name = '.'.join(name_parts)
271     image.save_meanfiltered_img(new_file_name)
272
273     meanfiltered_img = meanfiltered_img.resize((int(256 * 0.8), int(256 *
0.8)))
274     meanfiltered_img = ImageTk.PhotoImage(meanfiltered_img)
275     label_image2.config(image=meanfiltered_img)
276     label_image2.image = meanfiltered_img  # 处理后的图片的显示
277
278
279 if __name__ == "__main__":
280     root = tkinter.Tk()
281     root.title('21281280柯劲帆')  # 标题
282     width, height = 600, 400
283     width_max, height_max = root.maxsize()
284     s_center = '%dx%d+%d+%d' % (width, height, (width_max - width) / 2,
(height_max - height) / 2)  # 将页面显示在正中间
```

```
    root.geometry(s_center)
    root.resizable(width=False, height=False)  # 窗口不可移动
    l = tkinter.Label(root, text='实验三', width=60, height=2, fg='black', font=("微软雅黑", 16), anchor=tkinter.CENTER)
    l.pack()

    label_image1 = tkinter.Label(root, width=int(256 * 0.8), height=int(256 * 0.8), bg='whitesmoke', anchor=tkinter.NE)
    label_image1.pack()
    label_image1.place(x=45, y=70, width=int(256 * 0.8), height=int(256 * 0.8))

    label_image2 = tkinter.Label(root, width=int(256 * 0.8), height=int(256 * 0.8), bg='whitesmoke', anchor=tkinter.NE)
    label_image2.place(x=350, y=70, width=int(256 * 0.8), height=int(256 * 0.8))

    # 文本按钮
    Image_Input = tkinter.Button(root, text='Choose', command=choosepic)
    Image_Input.place(x=50, y=300, width=90, height=30)

    # 直方图均衡化
    Fun1 = tkinter.Button(root, text='直方图均衡化', command=equalize)
    Fun1.place(x=150, y=300, width=90, height=30)

    # 中值滤波
    Fun1 = tkinter.Button(root, text='中值滤波', command=medianfilter)  # 添加对应按钮
    Fun1.place(x=250, y=300, width=90, height=30)

    # 均值滤波
    Fun2 = tkinter.Button(root, text='均值滤波', command=meanfilter)  # 添加对应按钮
    Fun2.place(x=350, y=300, width=90, height=30)

    # 退出
    Quit = tkinter.Button(root, text='Quit', command=sys.exit)
    Quit.place(x=450, y=300, width=90, height=30)

    end = tkinter.Label(root, text='21281280 柯劲帆', fg='silver', font=("微软雅黑", 10))
    end.place(x=215, y=360, width=200, height=20)
    root.mainloop()
```