```
I = im2double(imread('.\Data\3.bmp'));

subplot(2,3,1);imshow(I);

title("原图");
```

计算特征频率图、最大幅度图和方向图（分成 Cos 图和 Sin 图）

```
[W, H] = size(I);

% 由于 8*8 实在太小，造成特征不够突出

% 因此取其邻域 32*32 来当作特征

% 虽然变成 32*32，但主要还是以左上的 8*8 为特征图

% 因此新高宽如下的 M 和 N

M = floor(W/8) - 3;

N = floor(H/8) - 3;

% 矩阵初始化

freq = zeros(M,N); %频率图
```

```
mag = zeros(M,N); % 最大幅度图

angs = zeros(M, N); % 角度图

Sin = zeros(M, N); % Sin 图

Cos = zeros(M, N); % Cos 图

for i = 1:M

    for j = 1:N

        I1 = I(i*8-7:min(i*8 + 24, end),j*8-7:min(j*8 + 24,end));

        dft = fftshift(fft2(I1,32,32));

        dft = abs(dft);

        dft(17,17) = 0;%去除直流分量

        [maxi, maxj] = MaxPoint(dft);

        freq(i, j) = sqrt((maxi - 17)^2 + (maxj - 17)^2);

        mag(i, j) = dft(maxi, maxj);

        % 将角度图分成 Cos 图和 Sin 图

        angs(i, j) = atan((maxj-17)/(maxi-17));

        Sin(i, j) = sin(angs(i, j) * 2);

        Cos(i, j) = cos(angs(i, j) * 2);

    end

end
```

```
mask = zeros(size(freq));

% 经过调参取得的参数

mask(mag < 78 & mag > 19 & freq < 8 & freq > 0) = 1;

% 形态学处理

mask = bwmorph(mask,'open');

mask = bwmorph(mask,'close');
```

```
mask = bwmorph(mask,'close');

se=strel('disk', 5);

mask=imopen(mask, se);

se=strel('disk', 15);

mask=imclose(mask, se);
```

抠出指纹区

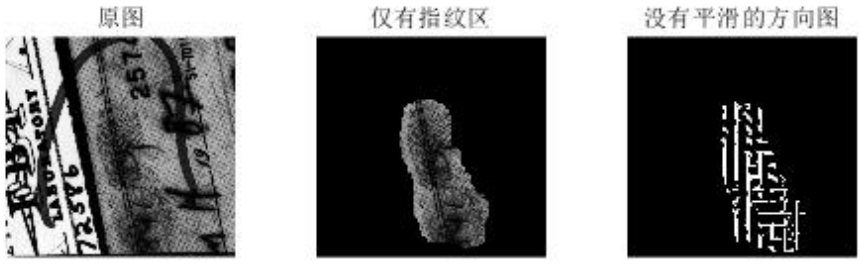
```
newmask = zeros(size(I));

[W, H] = size(I);

for i = 1:W

    for j = 1:H

        x = ceil(i / 8);

        y = ceil(j / 8);

        if mask(min(x,M),min(y,N)) == 1

            newmask(i, j) = 1;

        end

    end

end

NewI = I .* newmask;

subplot(2,3,2);imshow(NewI);

title("仅有指纹区");

imwrite(NewI, ".\Data\3_with_mask.bmp");
```

原图

仅有指纹区

```
orientimage = zeros(8*M,8*N); % 方向图初始化

for i = 1:M

    for j = 1:N

        if mask(i,j) == 1

            % 绘制初始方向图

            line = zeros(8,8);

            line(4:5,:) = 1;

            line = imrotate(line, angs(i,j) * 180 / pi, 'bicubic', 'crop');

            orientimage(8*i-7:8*i, 8*j-7:8*j) = line;

        end

    end

end

subplot(2,3,3);imshow(orientimage);
```

```
title("没有平滑的方向图");

imwrite(orientimage, ".\Data\3_orientimage.bmp");
```

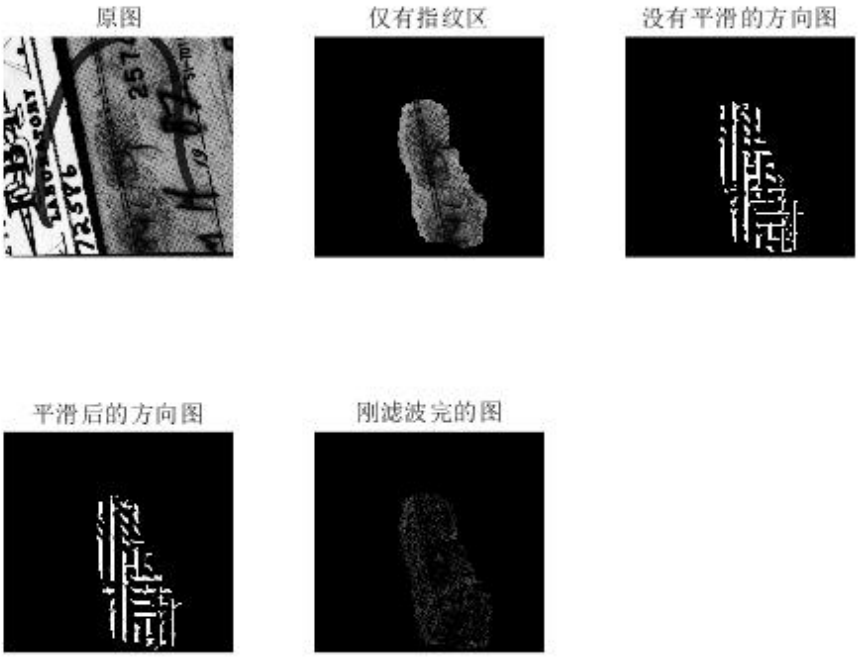


对 Sin 图、Cos 图和频率图做空域平滑

```
h = ones(3,3) ./ 9;

Sin = imfilter(Sin, h);

Cos = imfilter(Cos, h);

freq = imfilter(freq, h);

angs = atan2(Sin, Cos) / 2;

filterimage = zeros(size(I)); % 新图像初始化

H = ones(32,32);

for i = 1:M

    for j = 1:N

        if mask(i,j) == 1
```

```
                % 绘制平滑后方向图
                line = zeros(8,8);
                line(4:5,:) = 1;
                line = imrotate(line, angs(i,j) * 180 / pi, 'bicubic', 'crop');
                orientimage(8*i-7:8*i, 8*j-7:8*j) = line;
                % 利用陷波通过滤波器进行特征提取
                [DX, DY] = meshgrid(1:32);
                D0 = 20;
                n = 2;
                I1 = I(i*8-7:min(i*8 + 24, end),j*8-7:min(j*8 + 24,end));
                dft = fftshift(fft2(I1,32,32));
                dft(17,17) = 0;
                [maxi, maxj] = MaxPoint(dft);
                % 制作陷波通过滤波器
                Dk1 = sqrt((DX-maxi).^2+(DY-maxj).^2);
                Dk2 = sqrt((DX-32-2+maxi).^2+(DY-32-2+maxj).^2);
                H1 = 1./(1+(D0./Dk1).^(2*n));
                H2 = 1./(1+(D0./Dk2).^(2*n));
                H = H.*H1.*H2;
                H = 1 - H;
                dft = dft .* H;
                filterimage(i*8-7:min(i*8 + 24, end),j*8-7:min(j*8 + 24,end)) = real(ifft2(ifftshift(dft)));
            end
        end
    end
```

```
subplot(2,3,4);imshow(orientimage);

title("平滑后的方向图");

imwrite(orientimage, ".\Data\3_orientimage_smoothing.bmp");

subplot(2,3,5);imshow(filterimage);

title("刚滤波完的图");

imwrite(filterimage, ".\Data\3_filterimage.bmp");
```



先做像素的线性拉伸

```
filterimage = imadjust(filterimage, [0, max(max(filterimage))], [0,1],1);

% 再进行亮度调整

newfilterimage = filterimage;

newfilterimage(filterimage > 0.15) = 1;

subplot(2,3,6);imshow(newfilterimage);

title("亮度增强图");
```

```
imwrite(newfilterimage, ".\Data\3_filterimage_final.bmp");
```

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