

```
I=imread('..\data\输入\r96_4.bmp');
```

```
figure;
```

```
imshow(I);
```

```
I=im2double(I);
```

```
[M,N]=size(I);
```

```
%二值化
```

```
for i=1:M
```

```
    for j=1:N
```

```
        if I(i,j)<0.4981 && I(i,j)>0.498
```

```
            I(i,j)=1;
```

```
        end
```

```
    end
```

```
end
```

```
I=imbinarize(I,0.5);
```

```
figure;
```

```
imshow(I);
```

```
%形态学处理
```

```
se=strel('square',2);
```

```
I=imopen(I,se);
```

```
I=~bwareaopen(~I,50);
```

```
I=bwareaopen(I,10);
```

```
figure;
```

```
imshow(I);
```

```
%细化
```

```
lbw = ~bwmorph(~I, 'thin', 5);
```

```
figure;
```

```
imshow(lbw);
```

```
%细化后处理
```

%连接断裂

```
se=strel('square',2);
```

```
lbw=imerode(lbw,se);
```

```
lbw=imerode(lbw,se);
```

```
lbw = ~bwmorph(~lbw, 'thin', inf);
```

%去除桥接

```
B1=[0,1,1,0;0,0,1,0;0,0,1,0;0,0,1,0];
```

```
B2=[1,0,0,1;1,1,0,1;1,1,0,1;1,1,0,1];
```

```
hm=bwhitmiss(~lbw,B1,B2);
```

```
[x,y]=find(hm==1);
```

```
lbw(x(1)-1,y(1))=1;
```

```
lbw(x(1)-1:x(1)+2,y(1)+1)=1;
```

```
lbw(x(1)-2,y(1):y(1)+1)=0;
```

```
lbw(x(1)+3,y(1)+1)=0;
```

```
B1=[0,0,0,0,0;1,0,0,0,0;1,1,1,1,1;0,0,0,0,0;0,0,0,0,0];
```

```
B2=[1,1,1,1,1;0,1,1,1,1;0,0,0,0,0;1,1,1,1,1;1,1,1,1,1];
```

```
hm=bwhitmiss(~lbw,B1,B2);
```

```
[x,y]=find(hm==1);
```

```
lbw(x(2),y(2)-2:y(2)+5)=1;
```

```
lbw(x(2)-1,y(2)-2)=1;
```

```
lbw(x(2)+1,y(2)+3)=1;
```

```
lbw(x(2)-2,y(2)-2:y(2)+5)=0;
```

```
lbw(x(2)+2,y(2)-2:y(2)+3)=0;
```

%剪枝

```
C = ~Pruning(~lbw, 5);
```

```
figure;
```

```
imshow(C);
```

```
%细节点检测
```

```
lcn=zeros(size(l));
```

```
for i=2:M-1
```

```
    for j=2:N-1
```

```
        if C(i,j)==0
```

```
            cn=abs(C(i-1,j)-C(i-1,j-1))+abs(C(i-1,j+1)-C(i-1,j))+abs(C(i,j+1)-C(i-1,j+1))...
```

```
            +abs(C(i+1,j+1)-C(i,j+1))+abs(C(i+1,j)-C(i+1,j+1))+abs(C(i+1,j-1)-C(i+1,j))...
```

```
            +abs(C(i,j-1)-C(i+1,j-1))+abs(C(i-1,j-1)-C(i,j-1));
```

```
            lcn(i,j)=cn/2;
```

```
        end
```

```
    end
```

```
end
```

```
figure;
```

```
imshow(C);
```

```
%标注
```

```
[row,col]=find(lcn==1);
```

```
hold on, plot(col,row,'gs','MarkerSize',10)
```

```
[row,col]=find(lcn==3);
```

```
hold on, plot(col,row,'rs','MarkerSize',10)
```

```
%去掉边缘细节点
```

```
fun2 = @(x) std2(x);
```

```
ls = nlfiter(1,[3 3],fun2);
```

```
lbd=zeros(size(l));
```

```
for i=5:M-5
```

```
    for j=5:364
```

```
        if ls(i,j)~=0
```

```
            lbd(i-1:i+1,j:j+10)=1;
```

```
        break;
```

end
end
end
for i=5:M-5
for j=5:M-5
if ls(M-i,N-j)~=0
lbd(M-i,N-j-7:N-j)=1;
break;
end
end
end
figure;
imshow(lbd);
figure;
imshow(C);
%标注
[row,col]=find(lcn==3);
hold on, plot(col,row,'rs','MarkerSize',10)
lcn(lbd==1)=0;
[row,col]=find(lcn==1);
hold on, plot(col,row,'gs','MarkerSize',10)
%-----
function C = Pruning(A, len)
B = CreateEndpointSE();
X1 = A;
for k = 1:len

```
endpoints = false(size(A));
```

```
for m = 1:size(B,1)
```

```
    endpoints = endpoints | bwhitmiss(X1, B{m,1}, B{m,2});
```

```
end
```

```
    X1(endpoints) = 0;
```

```
end
```

```
X2 = false(size(A));
```

```
for m = 1:size(B,1)
```

```
    endpoints = bwhitmiss(X1, B{m,1}, B{m,2});
```

```
    X2(endpoints) = 1;
```

```
end
```

```
se = strel(ones(3,3));
```

```
X3 = X2;
```

```
for k = 1:len
```

```
    X3 = imdilate(X3, se) & A;
```

```
end
```

```
C = X3 | X1;
```

```
end
```

```
%-----
```

```
function B = CreateEndpointSE()
```

```
B{1,1} = [0 0 0; 1 1 0; 0 0 0];
```

```
B{1,2} = [0 1 1; 0 0 1; 0 1 1];
```

```
for k = 2:4
```

```
    B{k,1} = rot90(B{k-1,1});
```

```
    B{k,2} = rot90(B{k-1,2});
```

```
end
```

```
B{5,1} = [1 0 0; 0 1 0; 0 0 0];
```

```
B{5,2} = [0 1 1; 1 0 1; 1 1 1];
```

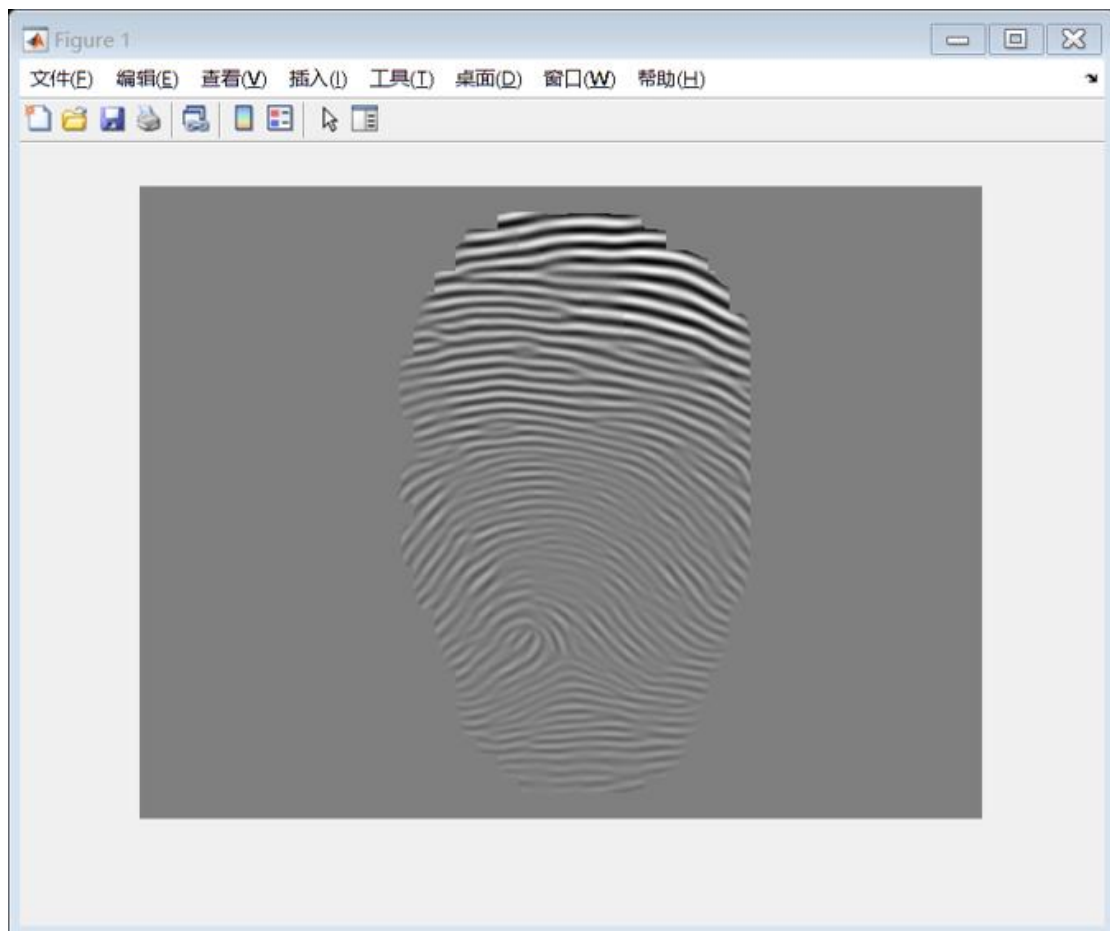
```
for k = 6:8
```

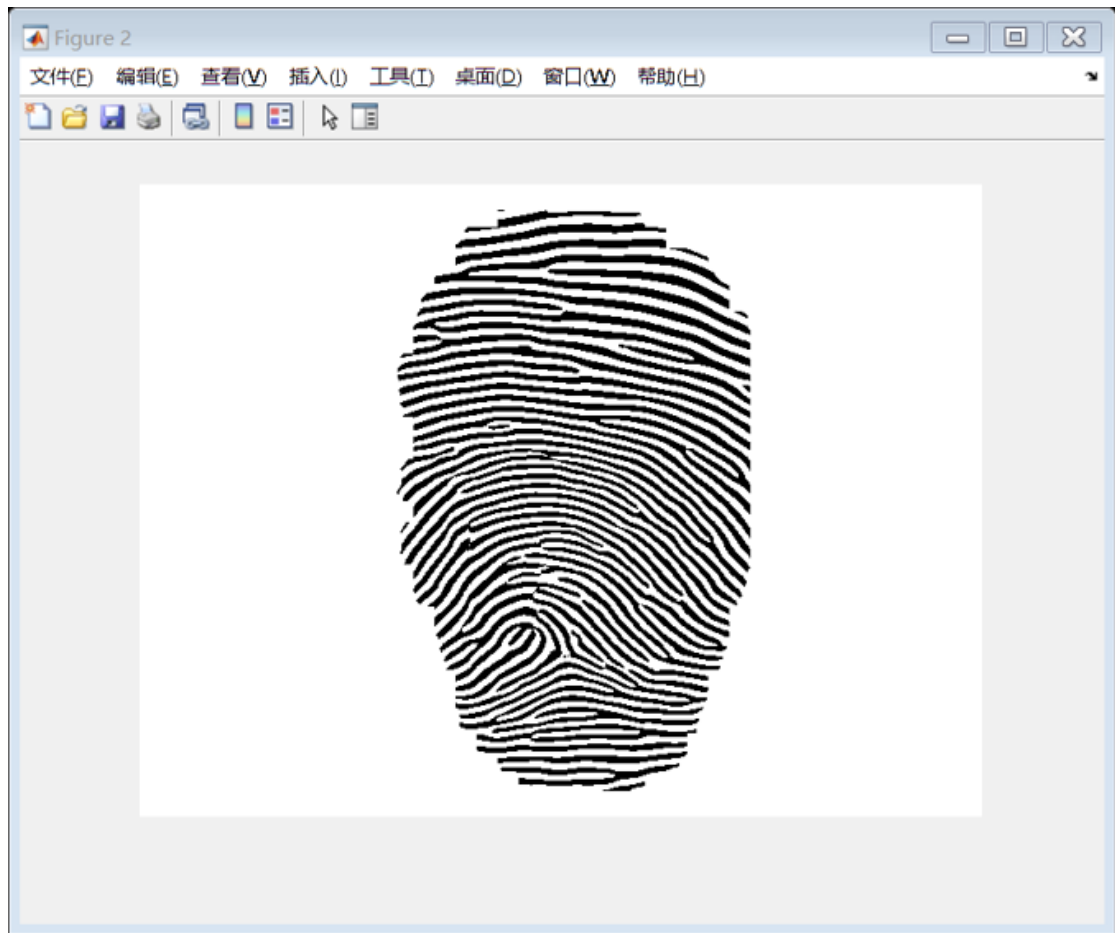
```
    B{k,1} = rot90(B{k-1,1});
```

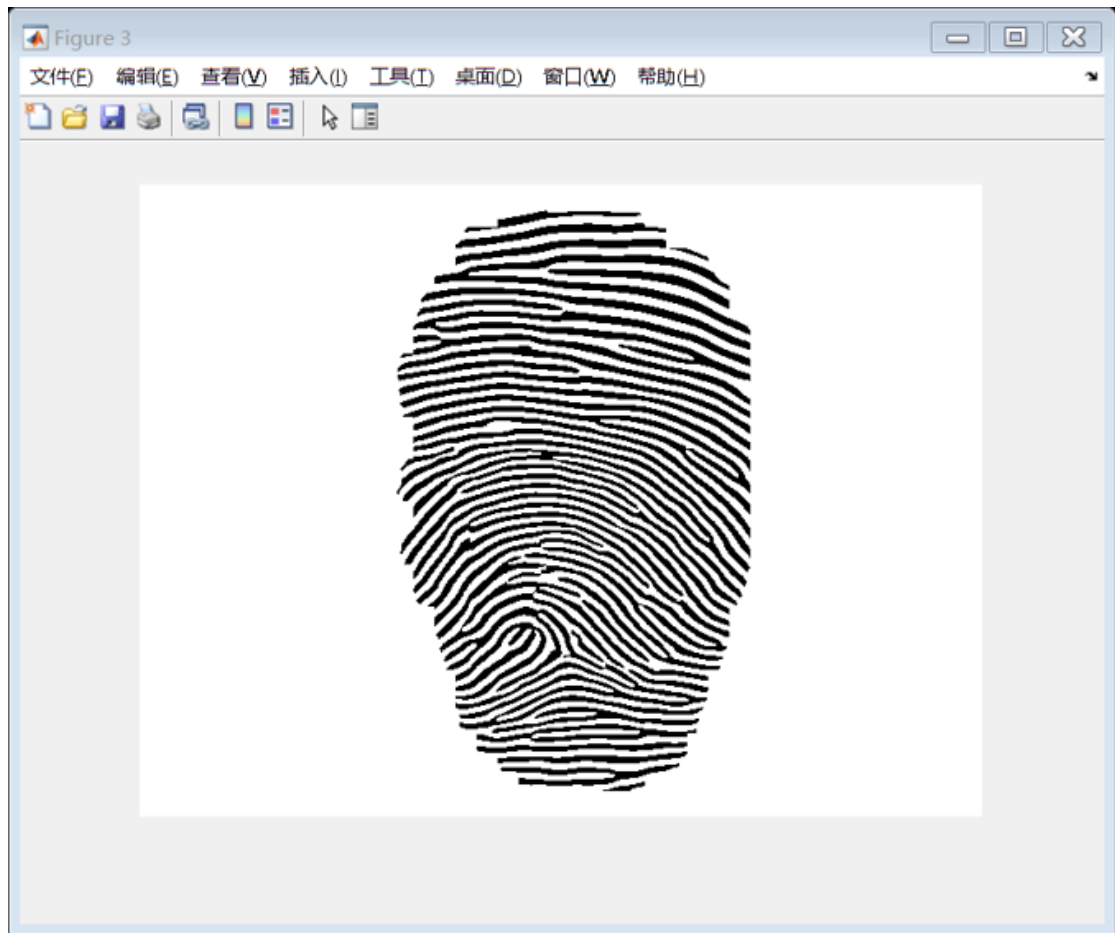
```
    B{k,2} = rot90(B{k-1,2});
```

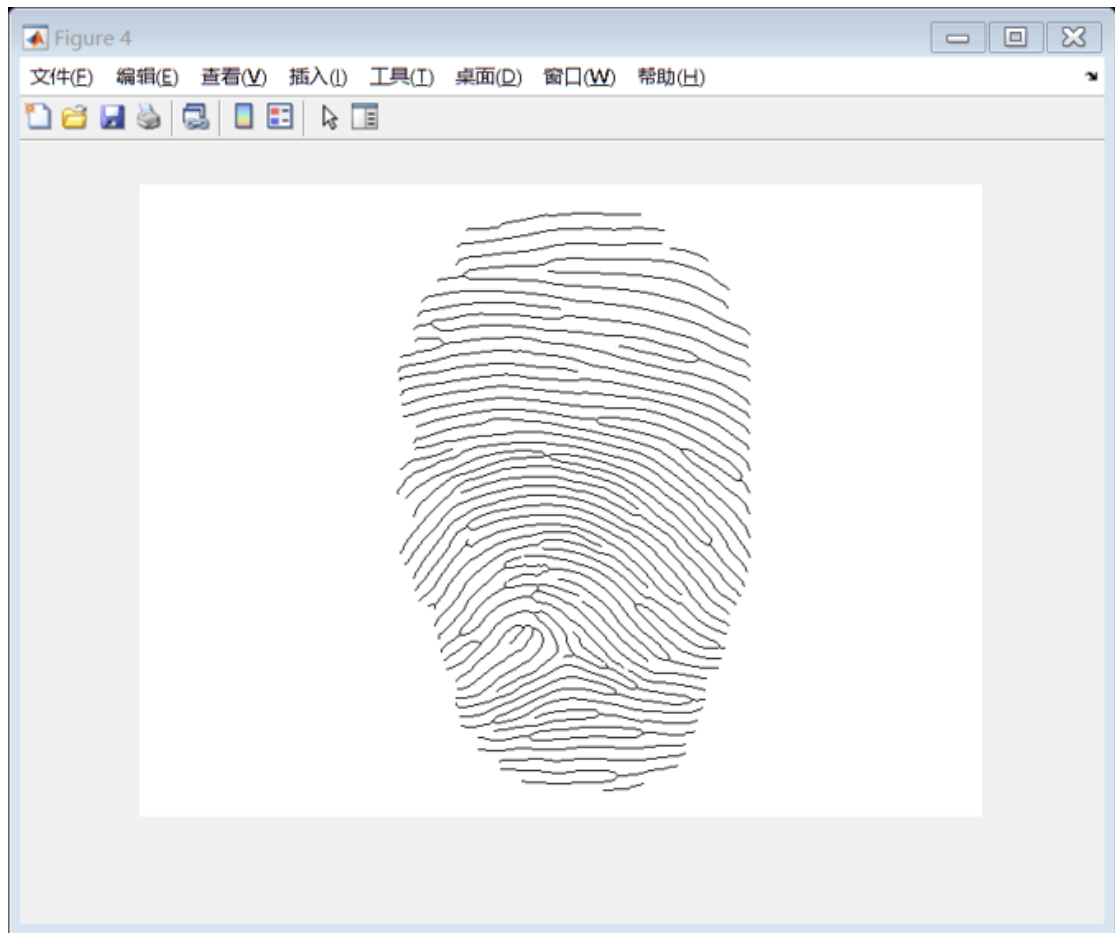
```
end
```

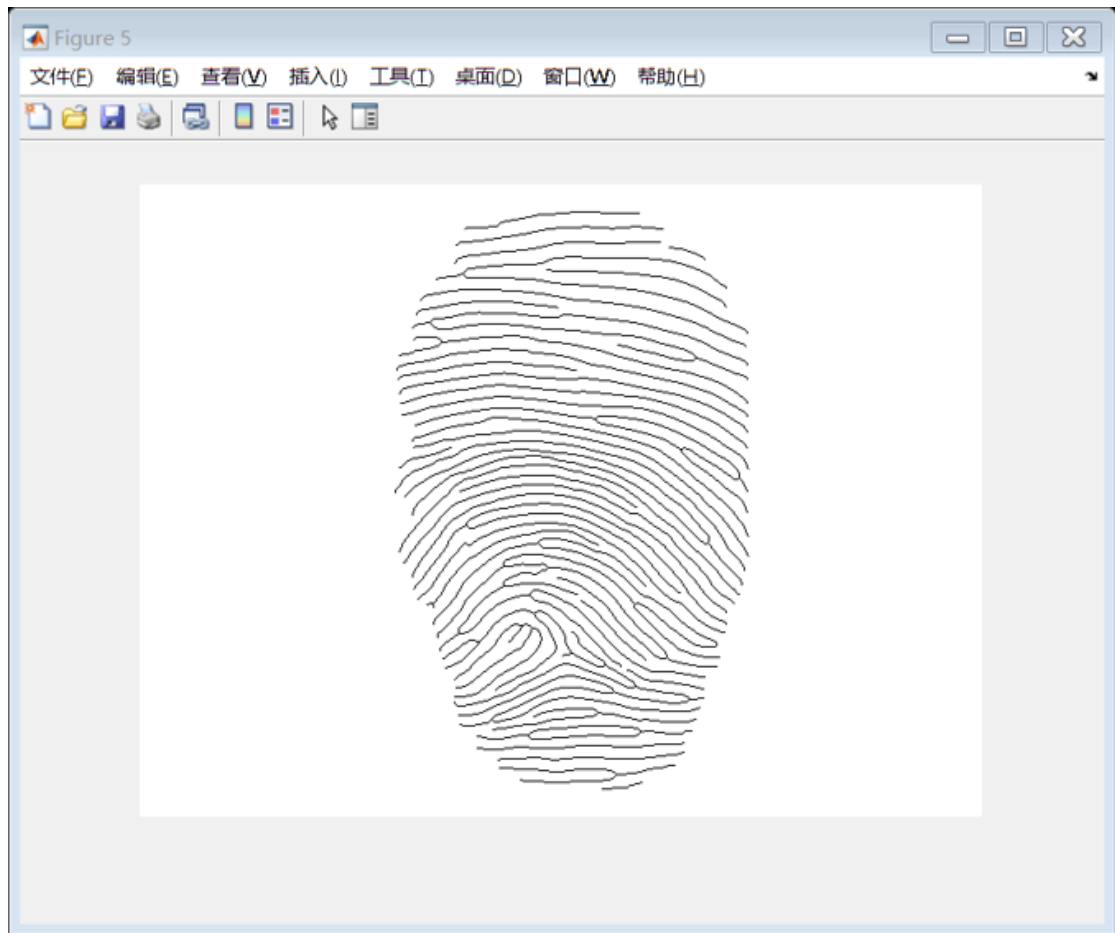
```
end
```

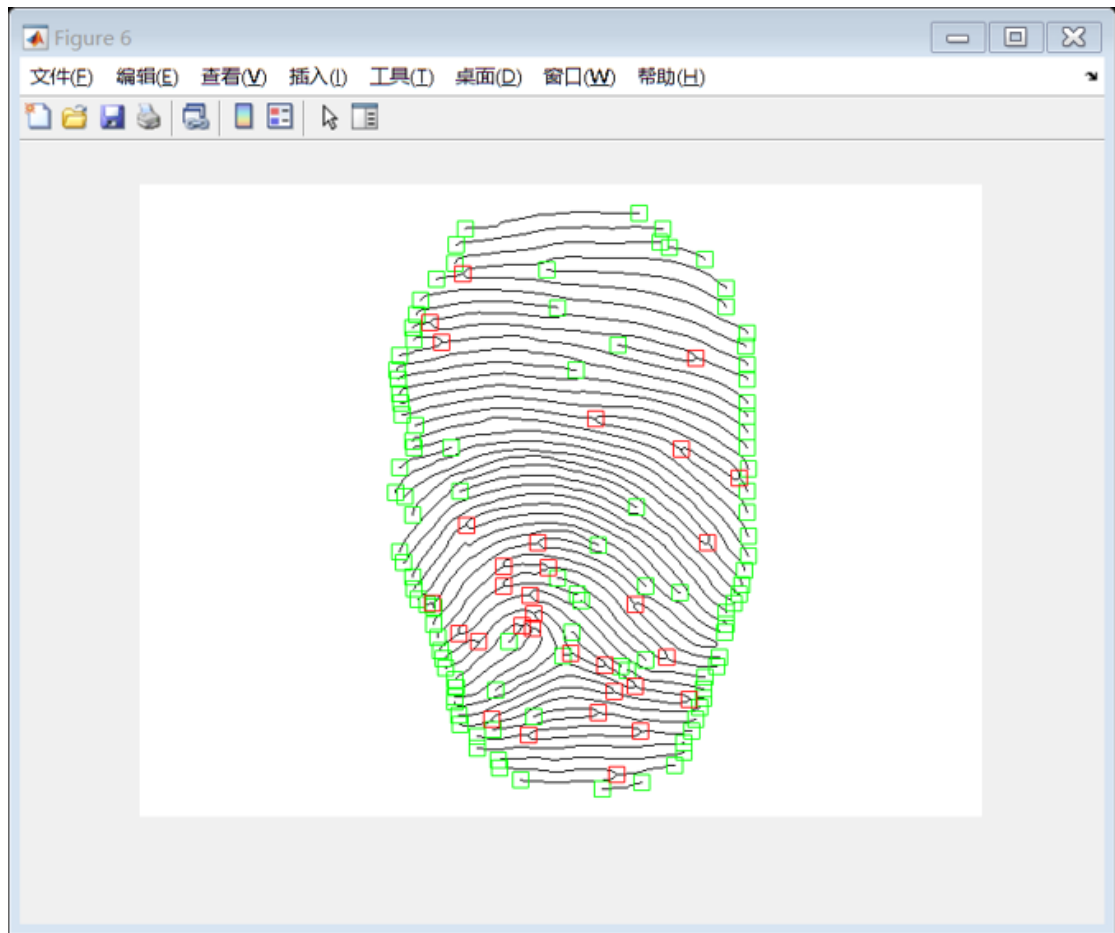


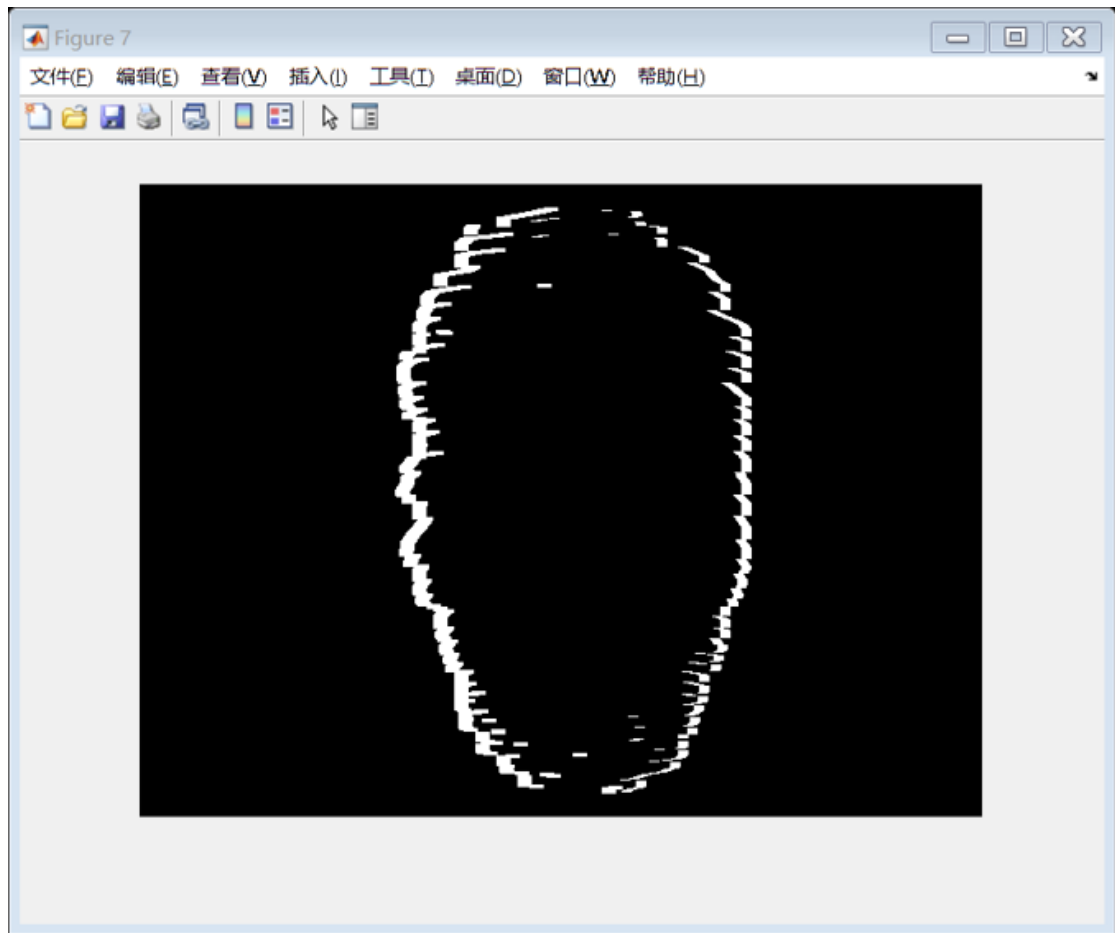


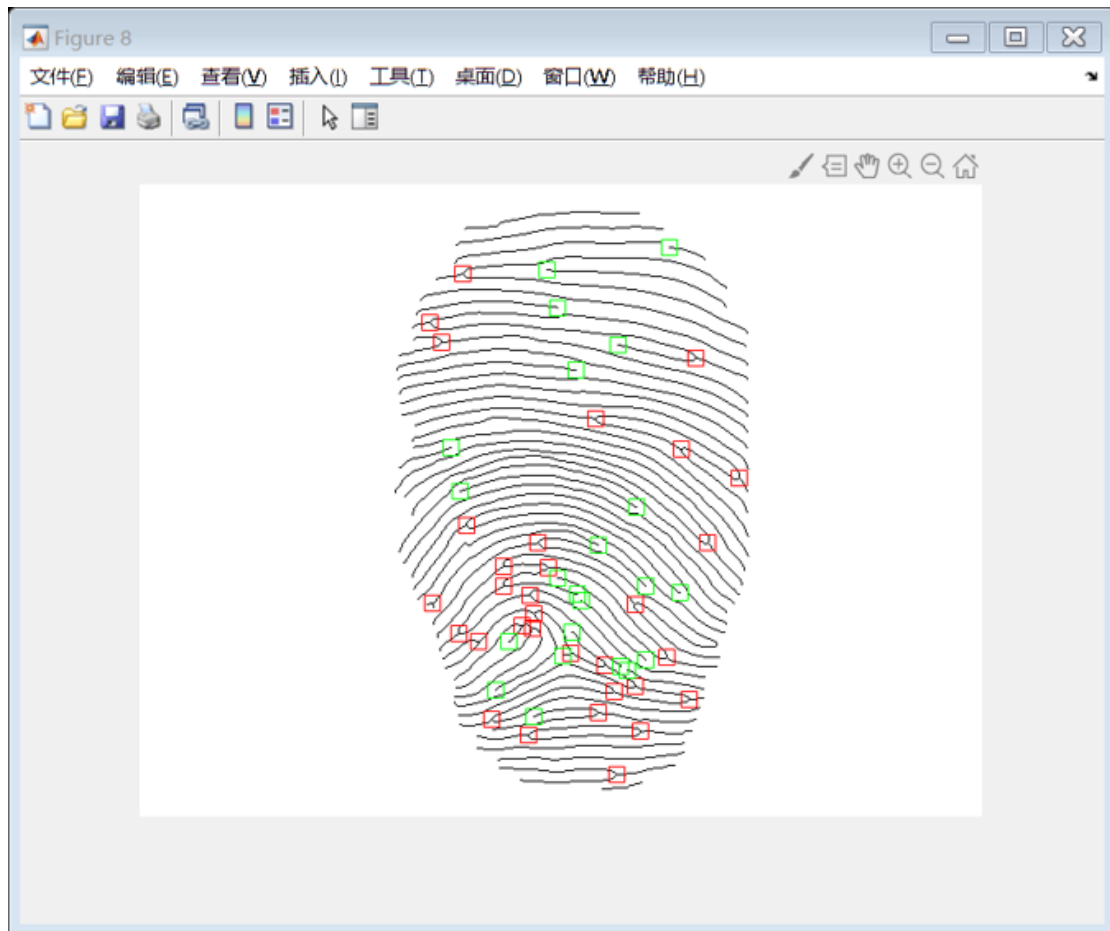












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