Digital Image Sharpening Processing based on MATLAB Software

Wang Mengyi
Department of Communication engineering
Shandong University of Technology
Shandong Province, China

Abstract:- With the development of science and technology, the application of digital image technology is more and more extensive, such as aircraft remote sensing and satellite remote sensing technology in aerospace technology, ultrasonic image processing in biomedical engineering, communication engineering wavelet transform image compression coding. As a part of digital image preprocessing, image sharpening plays an important role in enhancing and extracting the edge and contour of the scene in the image. This paper mainly studies single-direction first-order differential sharpening and directionless first-order differential sharpening. Relevant simulation codes are written by MATLAB software, and then corresponding conclusions are drawn by comparison.

Keywords:- *Image Sharpening Processing; MATLAB; Image Sharpening Algorithm.*

I. INTRODCUTION

MATLAB is a kind of software specially used for matrix numerical calculation, which has a unique advantage in reprocessing digital images. In theory, an image is a two-dimensional continuous function. However, when a computer performs digital processing on an image, it must first digitize it in space and brightness, which is the process of image sampling and quantization[1]. Image sharpening is a processing method proposed for the enhancement and extraction of target details and edge contour information. The function of image sharpening is to enhance the gray contrast of the image and highlight the edge and contour information. Digital image sharpening can be divided into unidirectional first-order differential sharpening and direction-free first-order differential sharpening.

II. UNIDIRECTIONAL FIRST-ORDER DIFFERENTIAL SHARPENING

Single-direction first-order sharpening refers to the enhancement of edge information in a specific direction of the image, which can only reflect the gray change of the specific direction of the image. Image is composed of horizontal and vertical directions, so single-direction first-order differential sharpening includes horizontal and vertical direction sharpening[2].

The expression of the horizontal sharpening operator is:

$$\begin{aligned}\triangledown f = &[f(x-1,y-1) - f(x+1,y-1)] \\ &+2[f(x-1,y) - f(x+1,y)] + \\ &[f(x-1,y+1) - f(x+1,y+1)]\end{aligned} \quad (1)$$

The expression of the vertical sharpening operator is:

$$\begin{aligned}\triangledown f = &[f(x-1,y-1) - f(x-1,y+1)] \\ &+2[f(x,y-1) - f(x,y+1)] + \\ &[f(x-1,y+1) - f(x+1,y+1)]\end{aligned} \quad (2)$$

III. DIRECTIONLESS FIRST-ORDER DIFFERENTIAL SHARPENING

The above sharpening results are effective for extracting the edges of artificially designed objects with rectangular features. However, for the irregular edge extraction, there is a defect of information. In order to solve the above problem, we hope to propose a sharpening algorithm sensitive to edge information in any direction. Because this kind of sharpening method requires no choice of the direction of the edge, it is called the directionless sharpening algorithm[3]. This paper mainly introduces Roberts operator, Sobel operator and Prewitt operator.

A. Roberts operator

Roberts operator is also called cross differential operator, and its calculation formula is

$$\begin{aligned}\triangledown f = &|f(x+1,y+1) - f(x,y)| + \\ &|f(x+1,y) - f(x,y+1)|\end{aligned} \quad (3)$$

Roberts operator uses a 2*2 template.

B. Sobel operator

The expression of Sobel operator is

$$\triangledown f = \sqrt{D_x^2 + D_y^2}$$

$$\begin{aligned}D_x = &[f(x+1,y-1) - f(x-1,y-1)] \\ &+2[f(x+1,y) - f(x-1,y)] + \\ &[f(x+1,y+1) - f(x-1,y+1)] \\ D_y = &[f(x-1,y+1) - f(x-1,y-1)] \\ &+2[f(x,y+1) - f(x,y-1)] + \\ &[f(x+1,y+1) - f(x+1,y-1)]\end{aligned} \quad (4)$$

Sobel operator is a 3*3 template. It is an odd-sized all-directional operator, which can place the pixels to be processed in the center position of the template[4]. Compared with Roberts operator, it avoids the dislocation problem of half a pixel.

C. Prewitt operator

The expression of the Prewitt operator is

$$\nabla f=\sqrt{D_x^2+D_y^2}$$

$$\begin{aligned} D_x &= [f(x+1,y-1)-f(x-1,y-1)] \\ &+[f(x+1,y)-f(x-1,y)]+ \\ &[f(x+1,y+1)-f(x-1,y+1)] \qquad (5) \\ D_y &= [f(x-1,\ y+1)-f(x-1,y-1)] \\ &+[f(x,y+1)-f(x,y-1)]+ \\ &[f(x+1,y+1)-f(x+1,y-1)] \end{aligned}$$

The Prewitt operator adopts the 3*3 template and is an omni-directional operator of odd size. Compared with the Sobel operator, the Priwitt operator only has different weights in the smoothing part.

IV. DESIGN OF CODE

A. Design of single-direction first-order differential sharpening code

The key parts of horizontal differential sharpening and vertical differential sharpening are given below:

```
for i=2:height-1
   for j=2:width-1
      I8(i,j)=F(i-1,j-1)+2*F(i-1,j)+F(i-1,j+1)
              -F(i+1,j-1)-2*F(i+1,j)-F(i+1,j+1);
   end
end

for i=2:height-1
   for j=2:width-1
      I9(i,j)=F(i-1,j-1)+2*F(i,j-1)+F(i+1,j-1)
              -F(i-1,j+1)-2*F(i,j+1)-F(i+1,j+1);
   end
end
```

The original image without processing is shown in Figure 1:

Fig 1 The original image

The running effects of horizontal differential sharpening and vertical differential sharpening codes are shown in Figure 2 and Figure 3:

Fig 2 First order horizontal sharpening image

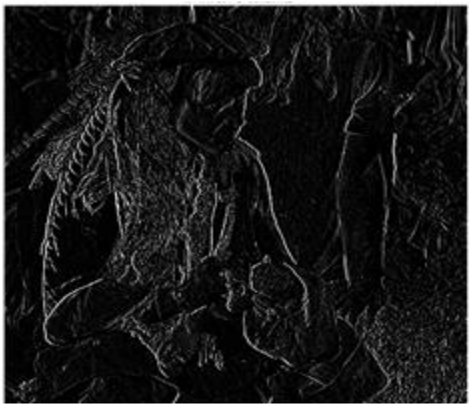

Fig 3 First order vertical sharpening image

B. Design of directionless first-order differential sharpening code

The Roberts operator, Sobel operator, and Prewitt operator codes run as follows:

```
w1=[-1 0;0 1];
w2=[0 -1;1 0];
G1=imfilter(F,w1);
G2=imfilter(F,w2);
G=abs(G1)+abs(G2);

for i=2:height-1
   for j=2:width-1
      I2(i,j)=sqrt((-F(i-1,j-1)-2*F(i-1,j)-F(i-1,j+1)
 +F(i+1,j-1)+2*F(i+1,j)+F(i+1,j+1))^2
+(-F(i-1,j-1)-2*F(i,j-1)-F(i+1,j-1)  +F(i-1,j+1)
+2*F(i,j+1)+F(i+1,j+1))^2);
   end
end

for i=2:height-1
   for j=2:width-1
      I3(i,j)=sqrt((-F(i-1,j-1)-F(i-1,j)-F(i-1,j+1)
 +F(i+1,j-1)+F(i+1,j)+F(i+1,j+1))^2+
(-F(i-1,j-1)-F(i,j-1)-F(i+1,j-1)  +F(i-1,j+1)
+F(i,j+1)+F(i+1,j+1))^2);
   end
end
```

The running effects of Roberts operator, Sobel operator and Prewitt operator code are shown in Figure 4, Figure 5 and Figure 6:

Fig 4 Roberts operator sharpens the image

Fig 5 Sobel operator sharpens the image

Fig 6 Prewitt operator sharpens the image

V. CONCLUSION

Unidirectional sharpening is effective for edge extraction of objects with rectangular features. However, there is an information defect in the extraction of irregular edges, which leads to the non-directional first-order differential sharpening. The template of Roberts algorithm is 2*2, and the extracted information is weak. Sobel sharpening edge information is strong, Sobel algorithm and Prewitt algorithm have the same idea, belong to the same type, so the processing effect is basically the same; Compared with Sobel algorithm, Prewitt algorithm has certain anti-interference and clean image effect[5].

In this paper, MATLAB in digital image sharpening processing aspects of simulation and discussion. The experimental results show that the application of MATLAB in digital image processing has ideal effect and high engineering value. MATLAB provides a simple, fast and effective method for digital image processing, which greatly improves the efficiency and effect of digital image processing and applies to all directions of image processing.

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