Variable Operator Image Contour Recognition Algorithm Based on Edge Sharpening

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Abstract: The current target contour recognition algorithm is prone to the problem of insufficient target contour extraction accuracy when the image target edge features are not obvious and the background is complicated. To make up for the shortcomings of the algorithm, this study proposes an edge-based approach. Sharpened variable operator image target contour recognition algorithm, by introducing Laplacian differential operator and Fourier transform, constructs the edge sharpening operator of the joint image, and then constructs the gradient feature based on the gradient feature. The target contour recognition algorithm of the variable operator image is used to measure the relevant parameters of the manufactured object. The experimental results show that compared with the generalized target contour recognition algorithm, the proposed algorithm can guarantee accuracy and stability in more complex uncertain environments.

1. Introduction

At present, with the increasing complexity of international political and economic forms, enterprises are facing an increasingly intensified competitive situation, realizing the deep integration of science and technology with production and manufacturing, thereby improving product quality and continuously improving production efficiency, which has become the commanding point for enterprises to cope with fierce market competition. In addition, with the gradual deepening of the concepts of “Industry 4.0” and “Made in China 2025”, the process of scientific and intelligent development of manufacturing industry has been accelerated. Target manufacturing is the core link of manufacturing enterprises. Among them, image target contour monitoring is the key process, which has an important impact on the quality and cost of manufacturing targets. At present, although there are some related technical equipment which can replace manpower to measure target parameters, when the characteristics of the target are not strong enough and there are complex backgrounds, it will lead to a sharp drop in measurement accuracy, which will affect the control of product quality and cost.

Based on this, domestic researchers have introduced image processing and computer vision technology into the detection of image target contour, but achieved remarkable results. However, the introduction of technology has dual character. This technology relies heavily on the clarity of image contour feature points. When such feature points show less obvious characteristics, contour extraction will first cause contour detection errors. In this paper, the object image is sharpened by Laplacian and Fourier enhancement operators, aiming at the feature of the object. Subsequently, on the basis of gradient feature, the object contour recognition operator is established to measure the perimeter and area of the object. Finally, the accuracy and stability of the variable operator image contour recognition algorithm based on edge sharpening are tested.

2. Object Contour Recognition Algorithms in this Study

The mechanism framework of this study is shown in Figure 1. Firstly, the industrial camera is used to collect the image of the manufacturing object; secondly, combined with Laplace image differentiation and Fourier transform, the image is enhanced and desiccated; finally, on the basis of image gradient characteristics, the contour edge of the image is defined, and the edge sharpening is carried out, and the relevant parameters are obtained by calculation.

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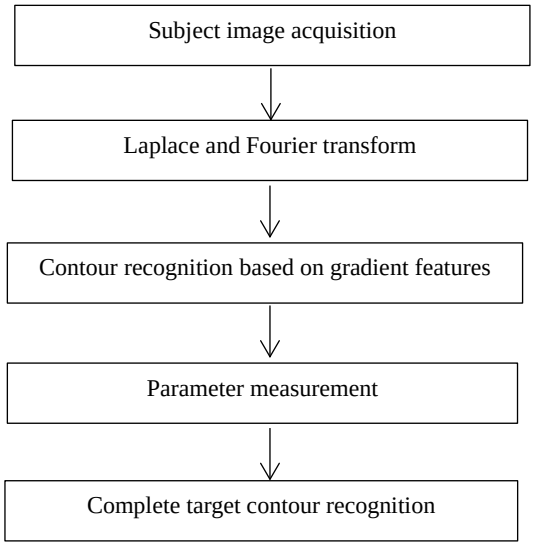

Fig. 1 The framework of this study

Figure 2 is a representative image with weak edge features. It can be seen that its background has high complexity and uncertainty. If the image is not processed in the traditional way, it will be difficult to recognize.

Figure 2. Weak target image with edge feature

3. Algorithmic Design

3.1 Edge Sharpening Based on Laplace and Fourier

Due to the weak edge features of the initial image of the object, the general edge detection algorithm based on contour can not accurately customize the edge of the object. The innovation of this study is to introduce edge sharpening operator based on Laplace differential and Fourier transform. Laplacian is essentially a differential operator. By emphasizing the abrupt gray-level region of the image, the effect of superimposing complex background and abrupt points in the image can be achieved, that is, image edge sharpening can be achieved, and background-related information can be restored. The Laplace transform and Fourier transform formulas of the image to be processed are as follows:

$$F(x,y)=\frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)e^{-2\pi(x/M+y/N)} \tag{1}$$

$$f(x,y)=\frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}F(x,y)e^{2\pi(x/M+y/N)} \tag{2}$$

Among them, f and F represent the original image and the image function after Fourier transform, M represents the length of the image, N represents the width of the image.

A remarkable advantage of the coupled Fourier transform and Laplacian enhancement operator in this study is that it can effectively avoid the influence of noise interference on the edge enhancement of image target, and make necessary data preparation for subsequent contour recognition.

Enhancement algorithm part code:

```
BYTE *Read8BitBmpFile2Img(const char * filename,int *width,int *height)
{FILE * BinFile;
BITMAPFILEHEADER FileHeader;
BITMAPINFOHEADER BmpHeader;
BYTE *img;
int size;
int Suc=1;
// Open File
*width=*height=0;
if((BinFile=fopen(filename,”rb”))==NULL) return NULL;// Read Struct Info
if(fread((void*)&FileHeader,1,sizeof(FileHeader),BinFile)!=sizeof(FileHeader)) Suc=-1;
if(fread((void*)&BmpHeader,1,sizeof(BmpHeader),BinFile)!=sizeof(BmpHeader)) Suc=-1;
if (Suc==-1) { fclose(BinFile); return NULL; }// Read Image Data
*width=(BmpHeader.biWidth+3)/4*4;*height=BmpHeader.biHeight;size=(BmpHeader.biWidth
+3)/4*4*BmpHeader.biHeight;fseek(BinFile,FileHeader.bfOffBits,SEEK_SET);
if ( (img=new BYTE[size+8])!=NULL)
{if(fread(img+8-int(img)%8,sizeof(BYTE),size,BinFile)!=(unsigned int)size)
{ fclose(BinFile);
delete img;
img=NULL;
return NULL;}}
fclose(BinFile);
return img;}
```

3.2 Object Contour Recognition Based on Gradient Features

After achieving the edge sharpening effect of the manufacturing object, the target contour is extracted. In this study, a detection operator using gradient feature to recognize the target contour is selected to detect the regions with significant gradient difference in the image. The difference between the edge sharpening and the background gradient is large. The gradient formula is as follows:

$$d = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \tag{3}$$

$$v = \left[(\frac{\partial f}{\partial x})^{1/2} + (\frac{\partial f}{\partial y})^{1/2} \right]^{1/2} \tag{4}$$

$$a = \arctan(\frac{\partial f}{\partial y} / \frac{\partial f}{\partial x}) \tag{5}$$

Among them, D represents the gradient vector, while V represents the gradient size and the a gradient vector. The edge position of the image to be recognized is determined by the local maximum between the gradient size and the direction angle. Regarding an area not in position 255 as its gray value is 0, or as its background, the recognition image is processed by edge sharpening operator under this principle, so that the edge contour of the image can be extracted, and then the

target contour of the image can be accurately extracted.

In addition, based on the consideration of further confirmation, the detection results of the image target contour are labeled on the original map, and the accurate proof of the target edge is carried out. After the proof results are obtained, the target contour is used as the edge contour to calculate the relevant parameters of the manufacturing object. The specific calculation formula is as follows:

$$z = \sum_{x=0,y=0}^{x,y\in l} L(x,y) \tag{6}$$

$$s = \sum_{x=.,y=0}^{x,y\in A} A(x,y) \tag{7}$$

In the formula above, Z represents the perimeter of the parameter, L represents the edge function of the image object, perimeter is the sum of the total number of pixels on the edge of the image; s represents the area of the region, A represents the inner function of the edge of the image object, and area is the sum of the total number of pixels on the edge of the image.

4. Experimental Analysis

Figure 2 shows the experimental image to be processed, and the target exists in the complex uncertain background. Based on the comparison of the advantages of this algorithm, the following figure 3 is the control group. Compared with the general target contour recognition technology, we can find that the edge sharpening based on Laplace and Fourier transform can significantly enhance the edge features of the target image, and extract the gradient features in the background of large gradient difference. It is beneficial to the recognition of target contour. In addition, it is noteworthy that the generalized target contour recognition technology relies too much on the difference of local pixel maxima when applying high-pass mean filtering. Under the complicated uncertain situation, the effect of image edge enhancement is not significant, and it is easy to lead to large deviation in recognition, which leads to errors. Error parameter data.

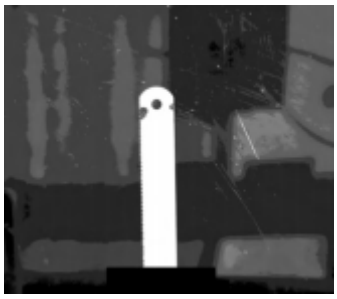

Fig. 3 Enhancement effect demonstration of the algorithm in this study

5. Conclusion

In the case of weak image edge features, target contour recognition is vulnerable to the influence of complex and unknown background, resulting in corresponding measurement errors and inaccuracies. Based on this, this study proposes a variable operator image target contour recognition algorithm based on edge sharpening. On the basis of edge sharpening processing, the image is expanded. Image contour extraction and target contour detection. Experiments show that the proposed algorithm has high recognition accuracy and robustness under complex and uncertain background, and can effectively benefit image contour recognition of manufacturing objects, and play a positive role in improving the quality of manufacturing objects.

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