Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(3):1062-1065

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The image edge detection algorithm based on the grey system theory

Duanli Yang, Hongmei Li and Yijin Wang

College of Information Science and Technology, Agricultural University of Hebei, Baoding, China

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ABSTRACT

in this paper the basic theory of a new edge detection algorithm is discussed, its application in image processing is analyzed and introduced as well. Considering the advantages of Grey system theory exploited in image edge detection, a mufti-scale morphological edge detection algorithm is proposed in this paper. At the end a new anti-noise edge detector is presented by improving the edge detector mentioned above in order to debut the detected edge efficiently and eliminate the influence of noise appropriately.

Key words: image edge detection; algorithm; Grey system theory

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INTRODUCTION

Image edge is the description of the remarkable change of gray between the neighboring pixels in the image. Digital image processing is improving an image into another image. Edge detection is an important direction of image processing. Edge image as the basic feather of the image includes the feather of the image space and image contour. It can be used in the analysis and treatment of superior layer of the feature description, image segmentation, image enhancement, image restoration, pattern recognition and image compression. It is available to further comprehension and analysis of the image. So many scholars dedicate to the research of the theory and practice for image edge detection. Many feasible detect methods are formed.

In recent years, digital image processing technology which is widely used in textile industry has obtained certain achievement in the field of fiber composition detection.In the process of the digital image processing, test analysis to the microscopic images of the fiber ,the way of extraction from the edge of the fiber , adhesion of the fiber separation accurately has a direct impact on fiber composition detection, is also an important part of fiber microscopic image recognition.

In 1982, the Chinese scholar, professor Julong Deng proposed Grey system theory which is a new method researching minority and the of poor uncertainty question. In recent years, the Grey system theory received the wide attention of scholars both at home and abroad, the Grey prediction and Grey relational analysis among Grey system theory are applied to the research of edge detection,the corresponding improved algorithm is proposed, the detection has been improved effectively, but can not meet the requirements of continuous fiber edge.Based on this, this paper proposed edge detection algorithm based on Grey system theory and the direction. This method combined the Grey forecasting model with Niblack algorithm, obtaining the edge of the fiber information for part of the fiber within the phenomenon of false edge, using area filling algorithm, direction graph algorithm and contour tracking algorithm to extract the edge of fiber completely.

Some domestic scholars attributed the problem of the image edge detection to poor information uncertainty systems , the Grey system theory is applied to the image edge detection , and has achieved certain results. Application of Grey system theory in this paper is mainly the Grey prediction model GM (1,1) and Grey absolute correlation degree , which is used to detect the fiber edge. Among them, the Grey prediction is based on the difference between the size of the gray gradation values of a predicted image and the actual point of the gray value to determine whether the

point is an edge point ; while the gray correlation is mainly based primarily on collating sequence associated with the reference sequence determine whether the point is an edge point .

The basic principles of Grey prediction

Through the neighborhood in one-pixel point build Grey prediction equation, and then use the Grey values of these points and the establishment of Grey prediction equations to predict this pixel Grey value , if the difference between the predicted and the actual value of the pixel Grey values is in the predetermined threshold value , the pixel is considered with its neighborhood in the same Grey value Grey on stage , which does not think the point of this pixel on the image edge ; otherwise , consider this pixel and its neighborhood is not the same Grey level , which determines the pixel is an edge point of the image. This method takes full advantage of the mutation of edge point gray value.

This algorithm in this paper is mainly based on fiber Grey value and the background on the edge of the area and the characteristics of internal Grey value of relatively large differences. Its basic algorithm thought: put image in the each pixel points corresponding to gray value considered initial series of Grey forecast model, then, put image in the pixel points x and its neighborhood pixel points into original sequence, accumulate the original sequence by using data processing for a regular series of Grey modeling, again for Grey forecast, after getting the forecast value sequence, for data reduction by that point in the actual forecast data ,if the difference between forecast value and actual value is larger, which is for edge points, otherwise, for non-edge points. The main steps of the algorithm of GM (1, 1) model are shown as follows:

(1) let the original sequence as

$$x^{(0)} = (x_{(1)}^{(0)}, x_{(2)}^{(0)}, \cdots, x_{(n)}^{(0)})$$

(2) generates a sequence for the record

$$x^{(1)} = (x_{(1)}^{(1)}, x_{(2)}^{(1)}, \cdots, x_{(n)}^{(1)})$$

Among them , $x_{(k)}^{(1)} = \sum_{i=1}^{k} x_{(i)}^{(1)} \quad k = 1,2,\cdots,n.$

(3) $z^{(1)}$ is close to $x^{(1)}$ as the mean value generates a sequence

$$z^{(1)} = (z_{(2)}^{(1)}, z_{(3)}^{(1)}, \cdots, x_{(n)}^{(1)})$$

Among them , $z_{(k)}^{(1)} = 0.5x_{(x)}^{(1)} + 0.5x_{(k-1)}^{(1)}, \cdots, k = 2,3,\cdots,n$

(4) GM (1,1) model that is an order of one yuan gray model, which is defined as

$$x_{(k)}^{(0)} + az_{(k)}^{(1)} = b$$

where: a is a factor of development; b is the Grey action.

(5) The whiting model of GM (1,1) is

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

(6) The albino-response of GM (1,1) is

$$\hat{x}_{(k+1)}^{(1)} = (x_{(1)}^{(0)} - \frac{b}{a})e^{-ak} + \frac{b}{a}$$

$$\hat{x}_{(k+1)}^{(0)} = x_{(k+1)}^{(1)} - \hat{x}_{(k)}^{(1)}$$

(7) under the least-squares criterion parameter

$$\begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T y^n$$

Among them ,

$$B=\begin{bmatrix} -z_{(2)}^{(1)} & 1 \\ -z_{(3)}^{(1)} & 1 \\ \vdots & \vdots \\ -z_{(n)}^{(1)} & 1 \end{bmatrix} \qquad y^n=\begin{bmatrix} x_{(2)}^{(0)} \\ x_{(3)}^{(0)} \\ \vdots \\ x_{(n)}^{(0)} \end{bmatrix}$$

The strong edge detection based on Grey prediction of Grey forecasting model of image edge detection studies focus on the sequence of points on the options, and options for sequence points improvements are only detects the edges more informative, does not meet the requirements of full fiber edge. Based on Grey forecast detection out of edge exists serious of fracture phenomenon, but its can accurate to find fiber edge of location, this paper has a new idea, puts Grey forecast application into fiber image of strong edge of detection, base on strength edge connection of thought, and put this strong edge and by Niblack value of the two algorithm get of weak edge for connection, then get fiber of edge information.

Based on the Grey prediction model in sequence point selection scheme and fiber image Gray scale characteristics analysis, the paper selected 12 masked sequences, and choose GM(1,1) model to model, thus get the strong edge in the fiber. The specific Grey prediction algorithm of the main steps are described below.

Let the size of an M × N image I, the Grey value of midpoint $I(i,j)$ is $g(i,j)$, $i=1,2,\cdots,M$, $J=1,2,\cdots,N$

(1)for each pixel in the image I, in turn, use mas sequences and $GM(1,1)$ model to calculate the gray forecast value of the center point x and constitutes the forecast image II.

(2) Original I minus the predicted figure II gets error images III, its gray value of each point is $\xi(i,j)$.

(3) According to the error histogram of the image, the threshold value T, if $\xi(i,j)>T$, the pixel image $B(i,j)=1$ is the binary image of strong edges , otherwise , $B(i,j)=0$, thus, getting the binary images of edges obtained by gray forecast model .

Grey correlation degree

Basic principles of grey correlation degree

According to the gray correlation analysis of the gray system theory, the size of the gray correlation reflects the reference sequence and comparative sequence similarity . According to the different features between the gray value of the image edge points and the gray value of the background area is large , it is understood that the edge and its neighboring pixel values consisting of comparison sequence associated with the reference sequence is relatively small. The calculating process of Grey absolute correlation degree are described as follows.

The calculation steps of correlation degree is as follows.

Let the reference sequence $X_0:\{x_i(k),k=1,2,\cdots,n$,

comparison sequence $X_i:\{x_i(k),k=1,2,\cdots,n$.

(1) initialization:

$$Y_0:\{\frac{x_0(k)}{x_0(1)}=y_0(k) \quad Y_1:\{\frac{x_i(k)}{x_i(1)}=y_i(k)$$

,

Initialized so that all sequences comparable.

(2) calculate the correlation coefficients of each point :

$$r(y_0(k),y_i(k))=\frac{1}{1+|(y_0(k+1)-y_0(k)-y_i(k+1)-y_i(k))|}$$
$$k=1,2,\cdots,n-1$$

(3) calculate the correlation degree:

$$r(x_0,x_i)=\frac{1}{n-1}\sum_{k-1}^{n-1}r(y_0(k),y_i(k))$$

Algorithm in this paper

Based on fiber identification system to extract the full edge of the grey prediction and grey correlation degree requirements and characteristics, this paper presents a grey forecasting, grey correlation degree and direction graph

based edge detection algorithm, the algorithm flow as shown in Figure 1.

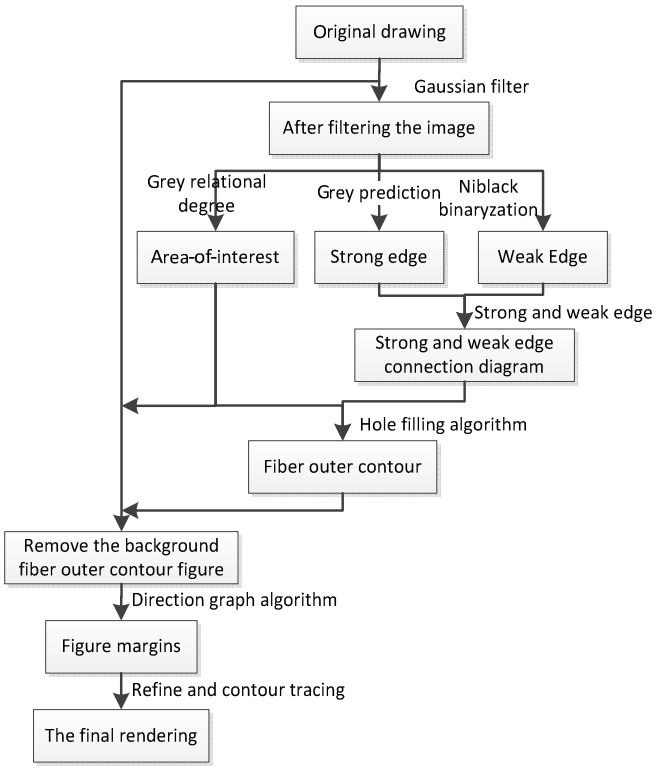

Fig.1 The algorithm process

CONCLUSION

The simulated result demonstrates that the edge detection algorithm has a performance of detected edge is noise reduction comp with traditional edge detectors, and the smooth. So this method has its practicability.

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