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Application of the image detection algorithm based on the grey system theory

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ABSTRACT

After doing research on fiber image with low quality and the grey prediction model, the grey correlation degree, directed graph and existing edge detection algorithm, this paper proposed a new edge detection algorithm to obtain complete and continuous edge. Proven by the experimental results, the proposed edge detection algorithm can overcome the defects of the conventional edge detection algorithm, such fracture as edge, false edge, etc.

Keywords: prediction model; detection algorithm; grey correlation theory

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INTRODUCTION

In recent years, 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

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

(2) generates a sequence for the record

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

Among them , $$x_{(k)}^{(1)} = \sum_{i=1}^{k} x_{(i)}^{(1)} \quad k = 1,2,\cdots,n. \quad (3)$$

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

$$z^{(1)} = (z_{(2)}^{(1)}, z_{(3)}^{(1)}, \cdots, x_{(n)}^{(1)}) \quad (4)$$

Among them , $$z_{(k)}^{(1)} = 0.5x_{(x)}^{(1)} + 0.5x_{(k-1)}^{(1)}, \cdots, k = 2,3,\cdots,n \quad (5)$$

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

$$x_{(k)}^{(0)} + az_{(k)}^{(1)} = b \quad (6)$$

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

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

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b \quad (7)$$

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

$$\overset{\wedge(1)}{x}_{(k+1)} = (x_{(1)}^{(0)} - \frac{b}{a})e^{-ak} + \frac{b}{a} \quad (8)$$

$$\overset{\wedge(0)}{x}_{(k+1)} = x_{(k+1)}^{(1)} - \overset{\wedge(1)}{x}_{(k)} \quad (9)$$

(7) under the least-squares criterion parameter

$$\begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T y^n \quad (10)$$

Among them ,

$$B = \begin{bmatrix} -z_{(2)}^{(1)} & 1 \\ -z_{(3)}^{(1)} & 1 \\ \vdots & \vdots \\ -z_{(n)}^{(1)} & 1 \end{bmatrix} \qquad y^n = \begin{bmatrix} x_{(2)}^{(0)} \\ x_{(3)}^{(0)} \\ \vdots \\ x_{(n)}^{(0)} \end{bmatrix} \quad (11)$$

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, put 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 k 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 grayscale characteristics analysis, the paper selected as shown in figure 1 of 12 mask sequence, and choose 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 sequence of Figure 1 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:

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

Extract the region of interest based on grey correlation

In this paper, through the analysis and research on the grey correlation degree, and basing on the gray value changes of background regions in fiber image is small and characteristics of gray value change of fiber internal is larger, the grey correlation degree is applied to fiber area, namely extraction of region of interest, and realize the innovation of grey correlation degree of application. In this paper, on the basis of predecessors' research to improve the selection of comparison sequence, were selected for eight neighborhood, up, down, left and right of four neighborhood pixels were composed of comparison sequences. So the selection of two comparison sequence, respectively

$k_1 = (g_{i,j}, g_{i-1,j}, g_{i+1,j}, g_{i,j-1}, g_{i,j+1}, g_{i-1,j-1}, g_{i-1,j+1}, g_{i+1,j-1}, g_{i+1,j+1}$

$k_2 = (g_{i,j}, g_{i-1,j}, g_{i,j}, g_{i,j-1}, g_{i,j}, g_{i,j+1}, g_{i,j}, g_{i+1,j}, g_{i,j}$ And let an equivalent sequence $k_0 = (1,1,1,1,1,1,1,1,1)$ as reference sequence, at which $g(i,j)$ as the grayscale values of point $I(i,j)$ .The algorithm steps are as follows :

(1) determine the reference sequence k_0 , and according to point $I(i,j)$ of the original image I to determine the comparison sequence $k_1(i,j)$ and $k_2(i,j)$;

(2) Absolute correlation $r_1(i,j)$ and $r_2(i,j)$ were calculated between k_0 and $k_1(i,j)$ with $k_2(i,j)$, take $r(i,j) = \min(r_1, r_2)$, whereby correlation diagram ;

(3) Threshold T is determined by the histogram of correlation chart, if $r(i,j) > T$, $I(i,j)$ is not a region of interest; otherwise, $I(i,j)$ is the region of interest and obtain a binary image of the region of interest.

CONCLUSION

This paper is based on the situation LOG operator , Prewitt operator , Canny operator and gray prediction model and gray correlation algorithm used double edge and contour extraction fiber fracture edge of existence , and the level set algorithm can not extract the exact position of the edge and fiber adhesion defects can

not be separated on the basis of gray system theory, the use of algorithms to detect patterns of fiber edge and using contour tracking well removing ,which reach the purpose of a good prospect of noise suppression, detection of precise and continuous fibers edge. The results of this study for subsequent fibers separation provides a very good foundation.

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