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Research of Rice Image Edge Detection Based on FCM Clustering Algorithm

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Abstract. Color is a primary way of people perception for recognizing image, with the development of science and technology and the improvement of computer processing capabilities, it is possible for researchers to deal with the multidimensional image data in color space, and it is regarded as a new hotspot of image processing. Many Color image edge detection algorithms for grayscale images are applied to divide the image edge detection; however, without making use of the image information effective, this kind of algorithms cannot get a reasonable result. By studying the characteristics of color images in HSI color space, and discussing its information of H (Huge) component, S (Saturation) component and I (Intensity) component. A kind of rice image edge detection algorithm- FCM clusters algorithm is proposed, and finding it is suitable for HSI space, the algorithm is implemented into MATLAB software. The simulation shows that the algorithm can segment the edge information of rice image well.

Keywords: edge detection, FCM cluster algorithm, HSI space.

1 Introduction

Color space information plays an important role for color image processing; many researchers are interested how to extract the edge of the color image. The edge detection is very important for image analysis and pattern. In this paper, design the algorithm to complete the edge detection in multidimensional color space. In HSI color space design the rice Image edge detection based on FCM clustering algorithm, it implements a simple, effective, and can achieve a good results.

2 Introduction of HSI Space

HSI color space model is described color feature by three parameters H, S, I, This space model can reflect people's sense of vision well on color. HSI color space is not only visually describing the image colors, and can reduce the complexity of color image processing; this will speed up the speed of color image processing. In the

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processing of color image, even if it's just using a color model in which one component will also achieve good results. Because of the three components of the HSI color model are easy to separation, and they are independent of each other, a lot algorithms used this space in image processing and computer vision [1].

HSI color space is obtained from RGB color space by nonlinear transformation. So (1) is the basic relationship through the RGB space to HSI space. The angle θ is mainly based on HSI space measured red shaft. Then we can achieve the H, S, and I.

$$\theta = \arccos\left\{\frac{1}{2}[(R-G)+(R-B)] / [(R-G)^2 + (R-B)(G-B)]^{1/2}\right\} \quad (1)$$

$$H = \begin{cases} \theta, & B \le G \\ 2\pi - \theta, & B > G \end{cases}, \quad S = 1 - \frac{3[\min(R,G,B)]}{R+G+B}, \quad I = \frac{1}{3}(R+G+B). \quad (2)$$

3 Design of the Fuzzy C-Means Clustering Algorithm

Fuzzy c-means is a kind of segmentation algorithm for fuzzy clustering in image feature space, its realization is the objective function of the nonlinear double iteration method, the objective function by using the weighted similarity between the clustering center and the image of each pixel is measured [2]. FCM algorithm design is primarily a sample set $X = \{x_1, x_2, \cdots, x_n\} \subset R^s$, s is the sample space of dimension, n is the sample number; c is the cluster of the sample division [3]. FCM algorithm can be described as (3):

$$Min\ J_{fcm}(U,V) = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}^{m} d_{ij}^{2}. \quad (3)$$

Enable

$$\sum_{i=1}^{c} u_{ij} = 1, \quad 1 \le j \le n. \ \sum_{j=1}^{n} u_{ij} > 0, \quad 1 \le i \le c. u_{ij} > 0, \quad 1 \le i \le c, \quad 1 \le j \le n \quad (4)$$

In the formula (3), we can know m>1 is fuzzy factor; $U = u_{ij}$ is a $c \times n$ fuzzy matrix, u_{ij} is the part of j sample, x_j belongs to the part of i membership degree; $V = [v_1, v_2, \cdots, v_c]$ is a $s \times c$ matrix that consists of c cluster center vector. $d_{ij} = \|x_j - v_i\|$ indicates the distance from the sample point x_j to the center v_i [4].

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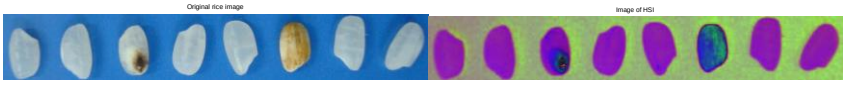
FCM algorithm design is mainly to set the number of clusters c and fuzzy-index m, initializing cluster centers $V^{(0)}$, set the precision of convergence ε >0, set the iterative number k=0. Using the (5) to calculate $U^{(k+1)}$ and $V^{(k+1)}$, and in (5), i, j must satisfy formula (4).

$$u_{ij} = \left[\sum_{r=1}^{c} \left(d_{ij} / d_{rj} \right)^{\frac{2}{m-1}} \right]^{-1}, \qquad v_i = \sum_{j=1}^{n} \left(u_{ij} \right)^m x_j / \sum_{j=1}^{n} \left(u_{ij} \right)^m \quad i = 1, 2, \ldots, c \tag{5}$$

Set k=k+1, repeat (5), until meet $\left\| V^{(k)} - V^{(k-1)} \right\| \le \varepsilon, \ k \ge 1$ that can terminate the operation.

4 Rice Image Processing in HSI Space

Each pixel in the rice image information is described by the three RGB values, which collected by image sensor. Taking into account earlier design algorithms, we will convert RGB space to HSI space for image processing through formula (1) and (2). The rice image is simulated by MATLAB in the HSI space, the rice image in the RGB space is shown of Fig.1 (a) and in the HSI space is shown of Fig. 1 (b).



(a) In the RGB space (b) In the HSI space

Fig. 1. The rice image

From the HSI image we can extract the H component; S component; I component of the rice image. The image is shown of Fig.2.

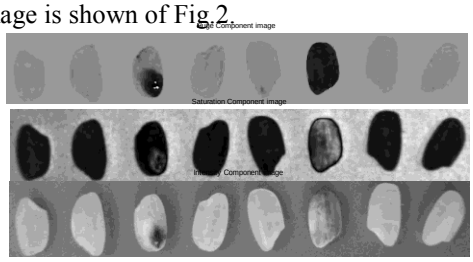


Fig. 2. The H component; S component; I component of HSI image.

5 Simulation and Verification of Rice Image Edge Detection with FCM Algorithm

According to the formula (3), in this paper, the value of c is 3, the value of m is 2, from the formula (5), and (6), set the objective function termination conditions is 10^{-5}.

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In the MATLAB environment, used the Fuzzy ToolBox tools to help design the FCM algorithm. We can divide the rice image complete through the FCM algorithm. The edge of rice can divide clear, it is shown of Figure 3.

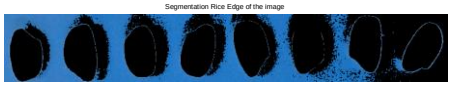

Fig. 3. The edge detection image of rice

By the simulation of FCM algorithm in MATLAB, From Fig3 we can observe this algorithm can divide the rice edge well. The simulation shows the cluster value of c is very important in this algorithm, if we can't ensure the value of c, we should spend more time in this algorithm, and this is not conducive to divide the edge of rice image.

6 Conclusion

The proposed algorithm can use rice image information effective in this paper, by studying the HSI color space model, the image information is converted from RGB space to HSI space to process. Through the analysis of rice image of H component, S component and I component in HSI space, known in HSI space for Color Image Edge extraction of rice is more appropriate. So in HSI space design of the rice image edge detection algorithm, and proved the FCM algorithm by MATLAB simulation. The simulation result shows that the algorithm can detect the edge of rice image quickly and completely.

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