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Research Article

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Research classification of Jujube based on BP artificial neural network

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ABSTRACT

In view of the draw backs of jujube grade identification in China, which still relies on photoelectric sorting and manual separation, this paper presents a processing method on the basis of the technology of computer vision and digital image. Utilizing image processing technology, the researcher extracted the red mean (R), green mean (G), blue mean (B) and their mean square error σ_R、σ_G、σ_B *and a total of 6 kinds of color characteristic variables from jujube image after pretreatment. Further made the image color spatial switching from RGB to HIS, then for the HIS color space, extracting the hue mean (H), intensity mean (I), saturation mean (S) and their mean square error* σ_H、σ_S、σ_I *and the total of 6 kinds of color characteristic variables, the total of 12 color characteristic variables, as the key characteristics of the BP input of network to build a network and identify the level of jujube through analysis of the external characteristics of jujube. The optimum structure parameters of the BP neural network which had 9 hidden layer neurons were determined by RP training algorithm. Results showed that average accuracy for fruit classification can reach 92.5% by using this model，and the executing time of microcomputer for grading of one jujube is 9.3 ms．This method has the characteristics of high accuracy and good real-time performance．*

Key words: Characteristic parameter; BP artificial neural network; jujube; Classification

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INTRODUCTION

The external quality of red jujube is the most important and direct sensory quality attributes. It Not only affect their sales price and the consumer choice, but also to some extent, will affect their internal quality[1]. The external quality of red jujube often referred to as color, texture, size, shape, and visual defects,etc.Methods of Manual separation were based mainly upon human observation to determine the level. There is lack of objectivity if relying solely on color characteristics and the naked eyes because of the jujube sizes and the complex situations of surface. Over the past few decades, the computer vision system has been widely used in food industry, the automatic detection in food and agricultural products, is a scientific and efficient tool[2].

The usefulness of image detection technology to identify agricultural research has been extensively researched and applied. Rehkugler and He Dong detected defects of jujubes, utilizing methods of the gray color degree detection of image and color classification[3,4]; ZHAO Maocheng used colored and near-infrared image to analyze the injury area of peaches to classify peaches[5]; LI Ping and Xiezhonghong invented new ways of colors grading on round chilis from the perspective of machine vision, with the correct rate up to 96%[6,7]; application of computer vision technology to test the quality of jujube and surface corruption[8]; and theory of image processing and neural network to determine long fruit, with accuracy rate over 96% with regard to grading of cucumber levels[9-11].

In this paper, image processing and analysis technology are combined with artificial neural networks to identify and

grade jujube. The key of this way is image manipulation algorithms and characteristic testing, linked to artificial neural networks through extracting valid characteristic parameter[12-14]. The experiment takes Xinjiang jujube as samples.

IMAGE PRE-MANIPULATION

The photos of mango, 640 × 480 pixel, 24-bit true color BMP, as shown in Fig.1.

Fig. 1. Jujube image

In the process of image-getting, the quality of image declined because of uneven light and transmission lines etc. So the images need pre-treating for extracting characteristic data. The image Pre-treatment shown in Fig.2.

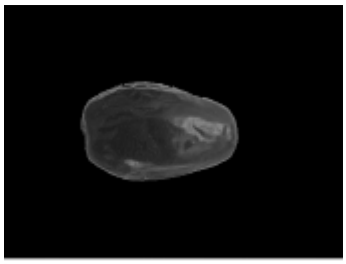

Fig.2: Process of image pre-treatment

In order to identify and grade jujube, the characteristics of a single jujube need extracting. The following focus on extraction method of color, shape, and other characteristics. Transforming from RGB to HSI can be done as equation1-3.

$$I = \frac{R+G+B}{3} \tag{1}$$

$$H = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} \tag{2}$$

$$S = 1-\frac{3\min(R,G,B)}{R+G+B} \tag{3}$$

According to the area feature in the Green theorem ， Calculate four levels(each contain 60) of jujube samples, and get mean score of 12 characteristics, identify the parameters $\overline{R}$、$\overline{G}$、$\overline{B}$、$\overline{H}$、$\overline{I}$、$\overline{S}$、σ_R、σ_G、σ_B、σ_H、σ_S、σ_I as a means of identification features. Because the dimension and value of the above four features have a different order of magnitude, so here be normalization process shown as equation

4[15].

$$P_i = \frac{p - \min(p)}{\max(p) - \min(p)} \qquad i = 1,2,3,\cdots,12 \tag{4}$$

Where, p is the features of jujube, Pi is the Normalized features.

JUJUBE-CLASSIFICATION UNDER BP ARTIFICIAL NEURAL NETWORK CHECKUP

The relation between the form feature and grading is comparatively complex which is hard to distinguish one from another. So we make use of BP network to establish the relationship between form feature and grading which is helpful to distinguish the different grades.

The BP network takes the normalized new vector as input, so the input of BP network is 4. According to GB / T10651 - 2008, fresh jujube level can be divided into excellent, first, second and substandard. So the output nodes are two output layer nodes, where 00 represents excellent, first class is 01, second 10, substandard grade 11 , representing four different levels of fruit. The input has 4 corresponding feature parameters, while the output is corresponding with the 4 grades of the jujube. This paper choose a single hidden layer and number of nodes in the hidden layer neurons can be got from the following empirical formula 5 [16].

$$n_1 = \sqrt{n+m} + k \tag{5}$$

Where n1 is hidden layer neuron numbers, n is input layer dimension, m is output layer dimension, k is the constant between 1 to 10.

Known above analysis , the input layer dimension n = 4, the output layer dimension m = 2, by the formula 5 n1 should be calculated between 4 to 13 , the specific values can be determined based on the training results . The optimum structure parameters of the BP neural network are determined by RP training algorithm. The 80 samples as training samples are made up of 30 jujubes in 4 different grades respectively. Network training epochs is set to 10000, training error is 0.005, min-grad is1e-10. The training results shown in Table 1.

Table.1 Result of training error under different hidden layer neuron numbers using BP neural network

Hidden-layer	4	5	6	7	8	9	10	11	12	13
RP error	0.032	0.014	0.019	0.012	0.013	0.005	0.005	0.006	0.015	0.006
Algorithm epochs	9890	10000	5403	7613	10000	8118	9685	2923	6364	5458

According to Table 1, within a predetermined number of epochs, only the hidden layers for 8 and 9 reach the target error. Considering the convergence speed and error，we select 9 as hidden layers .The BP NN grading figure is as Fig.3.

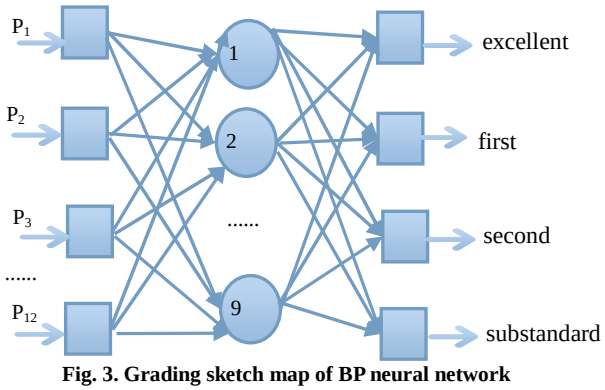

Fig. 3. Grading sketch map of BP neural network

NETWORK TRAINING AND THE RESULTS OF RECOGNITION

The relation between the form feature and grading is comparatively complex which is hard to distinguish one from another. So we make use of BP internet to establish the relationship between form feature and grading which is helpful to distinguish the different grades. The experiment is carried out with the help of 4 inputs, 4 outputs and select 120 samples as training samples which are made up of 30 jujubes in 4 different grades respectively. The training speed is fast, the ratio of identification is very high. The result is shown in table 2.

Table.2 Fruit grades predicted by BP neural network model

The grade of training samples	Artificial classification	Classification by BP neural network				Recognition rate of sample（%）
		excellent	first	second	substandard	
excellent	30	30				100
first	30		27	3		90
second	30		2	28		93
substandard	30		1	3	26	87

From table 2, there are relatively important parameters as color, mean square,shape,size. At the same time, these 4 features are more efficient. Excellent product is with 100% accuracy, first-class product is with 90% accuracy, second product is with 93% accuracy, substandard product is with 87% accuracy, and all samples are with an average rate of 92.5% accuracy. The average test time of each fruit 9.3 ms.

CONCLUSION

Separating jujube is based on image manipulation technology, through the border tracking algorithms. The research put forward to a new method of calculation that test the length of the long-short-axis, marked the location of it and calculated the 4 parameters, color, mean square,shape,size, as the key characteristics of the BP input of network to build a network and identify the level of jujube. The result of experiment indicates that the calculating method and judging of the level of jujube are precise and accurate, with an average recognition rate of 92.5%.

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