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**Journal of Chemical and Pharmaceutical Research, 2014, 6(2):129-132**

**Research Article**

**ISSN : 0975-7384**
**CODEN(USA) : JCPRC5**

# Detection level of mango based on neural network and digital image

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**ABSTRACT**

*In view of the draw backs of mango 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 calculated the length of the long-short-axis, marked the location of it and calculated the 7 parameters, chroma, length, width and etc.,4 of which are chosen as the key characteristics of the BP input of network to build a network and identify the level of mango through analysis of the external characteristics of mango. The method is based on traditional characteristics detection, using boundary tracking algorithm and the length of the new long-short-axis detection algorithm. The result of experiment indicates that the calculating method and judging of the level of mango are precise and accurate, with an average recognition rate of 92%. Therefore, the method has a great practical value, which can be applied to other agricultural products classification.*

**Key words:** image manipulation; characteristic parameter; neural network; Mango; detect level

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## INTRODUCTION

The usefulness of image detection technology to identify agricultural research has been extensively researched and applied. Rehkugler and He Dong detected defects of apples, utilizing methods of the gray color degree detection of image and color classification[1,2]; ZHAO Maocheng used colored and near-infrared image to analyze the injury area of peaches to classify peaches[3]; 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%[4,5]; application of computer vision technology to test the quality of mango and surface corruption[6]; and theory of image processing and neural network to determine long fruit, with accuracy rate over 96% with regard to grading of cucumber levels[7].

At present, there are photoelectric sorting and manual separation with regard to distinguish the grading of mango. 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 mango sizes and the complex situations of surface. Method of photoelectric separation is based primarily on color characteristics, utilizing surface testing to determine level of mango, which is made up of material delivering equipment, light boxes, electronically controlled lines and pneumatic system to distinguish the colors of Raisin [8-11]. It controls circuits complicatedly and need higher level of users, which restricts its application.

In this paper, image processing and analysis technology are combined with artificial neural networks to identify and grade mango. The key of this way is image manipulation algorithms and characteristic testing, linked to artificial neural networks through extracting valid characteristic parameter [12-15]. The experiment takes Panzhihua mango as samples.

**IMAGE PRE-MANIPULATION**

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

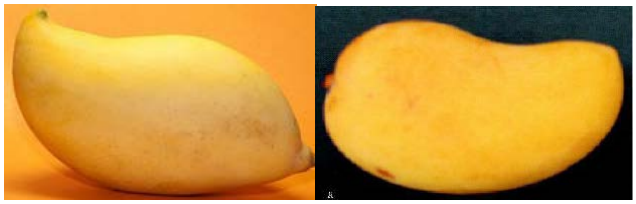

**Fig. 1Mango image**

*(The left: High-grade mango image; The right: First -grade mango 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 is shown in Fig. 2.

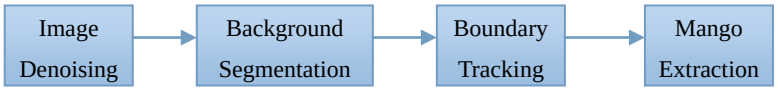


**Fig. 2 Process of image pretreatment**

Making the background is white, non-background part of the original image is retained, and set the corresponding pixel of the original image to 255. In this way, non-background part of the original image is retained, making the background white. The colored image of mango can be indicated as R(red), G(green) and B(blue). Based on the When segmenting the background of color images, the researcher first conducted threshold as far as the gray image concerned, and then compared the original color image with treated image. If pixel is 255(having treated image, the threshold is shown as the equation 1:

$$R(i,j)=\begin{cases} R_0(i,j) & R_0(i,j)\le T_r \\ 255 & R_0(i,j)>T_r \end{cases}$$

$$G(i,j)=\begin{cases} G_0(i,j) & G_0(i,j)\le T_g \\ 255 & G_0(i,j)>T_g \end{cases}$$

$$B(i,j)=\begin{cases} B_0(i,j) & B_0(i,j)\le T_b \\ 255 & B_0(i,j)>T_b \end{cases} \quad (1)$$

R0 ( i , j ),G0 ( i , j ) , B0( i , j ) and R( i , j ),G( i , j ),B( i , j ) are gray value of three-channel pixel before and after the background segmenting.; Tr, Tg, Tb are the threshold of segmenting background for three channels R, G and B. The result of segmenting is shown in Fig.3:

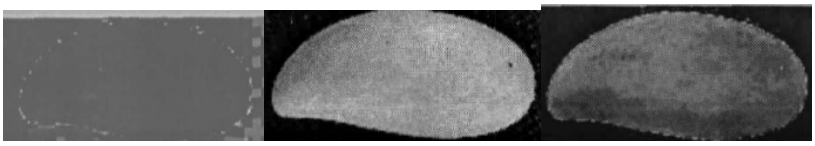

**Fig. 3 Results of background segmentation in three channels**

*(The left: Segmentation in R channel; The middle: Segmentation in G channel; The right: Segmentation in B channel)*

Compared the three pictures, the researcher found that while segmentation in B channel, the information of mango remained integral; However, Segmentation in R & G channel, part of information lost. Therefore because of the largest instance between the two peaks which is helpful for the correct choice of the threshold, the effect in histogram B with background segmentation is quite good.

**SELECTION AND EXTRACTION OF CHARACTERISTICS PARAMETER**

In order to identify and grade mango, the characteristics of a single mango need extracting. The following focus on extraction method of color, shape, and other characteristics. Transforming from RGB to HSI can be done as equation2-4.

$$I = \frac{R+G+B}{3} \tag{2}$$

$$H = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} \tag{3}$$

$$S = 1 - \frac{3\min(R,G,B)}{R+G+B} \tag{4}$$

According to the area feature in the Green theorem ,Calculate three levels(each contain 60) of mango samples, and get mean score of 7 characteristics, identify the parameters color, saturation, brightness, long, area, length and width as a means of identification features. As shown in table 1.

**Table.1 Average of mango features**

| Grade | H | S | I | P | A | L | M |
|---|---|---|---|---|---|---|---|
| High | 65.7560 | 0.4811 | 0.3355 | 133.7500 | 140.2401 | 19.9255 | 9.6232 |
| First | 55.1069 | 0.4506 | 0.3576 | 124.8903 | 102.6010 | 17.3508 | 7.9682 |
| Second | 45.1093 | 0.5245 | 0.4028 | 93.0393 | 67.4188 | 14.1359 | 6.3648 |

**MANGO GRADE-LEVEL UNDER BP 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 internet to establish the relationship between form feature and grading which is helpful to distinguish the different grades.

The input of BP network is 7, the output nodes are 3 and there is an implied layer. The input has 7 corresponding feature parameters, while the output is corresponding with the 3 grades of the mango. The initial study velocity is 0.01.self- study velocity is adopted. The target error is 0.001. The NN grading figure is as Fig.4:

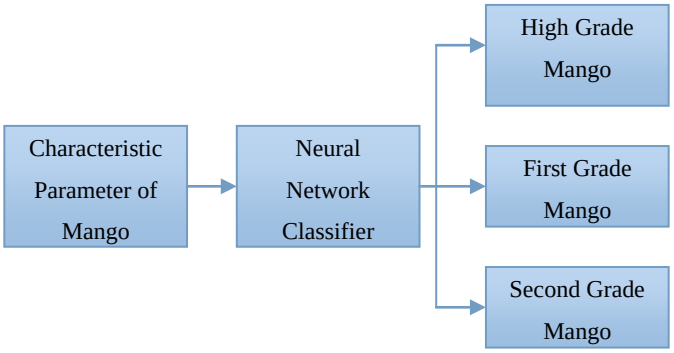


**Fig.4 Grading sketch map of neural network**

The 180 samples are made up of 60 mangos in 3 different grades respectively. Identifiable samples are 120 mangos with 40 mangos of each grading. In order to make them belonging to the same scope, the data is normalized. P is the input matrix, among which there are 7 feature parameters and 5 samples of different grades.

$$P = \begin{bmatrix}
1.0000 & 0.3897 & 0.3030 & 0.6324 & 0.4832 & 0.7399 & 0.3289 \\
0.8760 & 0.4410 & 0.3010 & 0.6087 & 0.7311 & 0.9824 & 0.5616 \\
0.7391 & 0.4272 & 0.3397 & 0.5427 & 0.6040 & 0.7419 & 0.4176 \\
0.9275 & 0.4070 & 0.2897 & 0.8154 & 0.8380 & 0.8765 & 0.8641 \\
0.7205 & 0.4163 & 0.3463 & 0.9414 & 0.6571 & 0.8604 & 0.4583 \\
0.4663 & 0.4437 & 0.3420 & 0.3787 & 0.3267 & 0.4352 & 0.3435 \\
0.4560 & 0.4979 & 0.3229 & 0.5206 & 0.3821 & 0.4277 & 0.4334 \\
0.4090 & 0.4651 & 0.3501 & 0.5721 & 0.3526 & 0.4919 & 0.2890 \\
0.4575 & 0.3948 & 0.3526 & 0.6057 & 0.4079 & 0.4795 & 0.4450 \\
0.4973 & 0.4446 & 0.3129 & 0.6361 & 0.3838 & 0.4982 & 0.3667 \\
0.0719 & 0.4621 & 0.3881 & 0.2759 & 0.2474 & 0.4381 & 0.1826 \\
0.1663 & 0.5432 & 0.3454 & 0.1596 & 0.2348 & 0.4304 & 0.1475 \\
0.3518 & 0.5858 & 0.3938 & 0.1034 & 0.1970 & 0.4255 & 0.1661 \\
0.1614 & 0.4496 & 0.4058 & 0.1669 & 0.1412 & 0.2899 & 0.0289 \\
0.3157 & 0.5111 & 0.3871 & 0.1635 & 0.1547 & 0.2041 & 0.2498
\end{bmatrix}$$

T is the target matrix, each set of parameters is corresponding to an output vector. Each element stands for a grade. In the target output, 1 stands for the grade of the target output.

$$T = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

**NETWORK TRAINING AND THE RESULTS OF RECOGNITION**

The experiment is carried out with the help of 7 inputs, 3 outputs and a middle layer with 17 nerve cells. The training speed is fast, the ratio of identification is very high. The result is shown in table 2.

**Table.2 Recognition rate of different parameters**

| Parameter number | H | S | I | P | A | L | M | epoch of learning | Recognition rate of sample(%) |
|---|---|---|---|---|---|---|---|---|---|
| 7 | √ | √ | √ | √ | √ | √ | √ | 968 | 91 |
| 6 | √ | √ | | √ | √ | √ | √ | 965 | 91 |
| 5 | √ | | | √ | √ | √ | √ | 1179 | 85 |
| 5 | | √ | | √ | √ | √ | √ | 935 | 88 |
| 4 | √ | | | √ | | √ | √ | 951 | 90 |
| 4 | √ | | | √ | √ | √ | | 1183 | 86 |
| 4 | √ | | | √ | √ | | √ | 930 | 88 |
| 4 | √ | | | | √ | √ | √ | 905 | 92 |

From table 2, there are relatively important parameters as chroma, area, length, width. At the same time, these 4 features are more efficient than those 7 features. So the cyber structure adopts the system with 7 inputs, 3 outputs and a middle layer with 17 nerve cells.

## CONCLUSION

Separating mango 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 7 parameters, chroma, length, width and etc.,4 of which are chosen as the key characteristics of the BP input of network to build a network and identify the level of mango. The result of experiment indicates that the calculating method and judging of the level of mango are precise and accurate, with an average recognition rate of 92%.

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