A Feature Extraction and Description Method of Fruit Image Based on Computer Vision

Chunhua Qian [1,2,a], Hequn Qiang[1,3,b]*and Yi Ren[1,c]

[1]Department of Computer Science Suzhou Polytechnic Institute of Agriculture Suzhou, China
[2]Department of Forestry Science Nanjing Forestry University Nanjing, China
[3]Computer Science & Technology Soochow University Suzhou, China

[a] qch_szai@sina.com;[b] borisqiang@sina.com;[c] 893917817@qq.com

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Abstract. Automatic fruit quality classification based on computer image processing is accurate and efficient. In this paper, we discuss the orange feature extraction and description method based on image processing. Design an orange image edge detection method based on Canny operator, color characteristics description methods based on HIS model and shape characteristics description methods based on Fourier descriptor operator. The experiment result proof that Canny operator is high SNR, high accuracy and low computation; HIS model is more accord with human vision and low computation also; shape characteristics description methods based on Fourier descriptor operator is more easy to shape classification.

Introduction

The quality classification of fruits is very important to improve the economic benefit of agriculture and income of farmers. At the present time, fruit quality classification mainly by hand, the whole process is waste of labour and inefficient. Therefore, research of automatic fruit quality classification technology based on computer image processing is significanct.

The first step of automatic fruit quality classification process is extraction the fruit feature from the images, and describe the features with some proper methods. These features will be used in quality classification of fruit later.

We mainly discuss the fruit feature extraction and description in this paper. Section 1 contains the edge detection based on Canny operator. Section 2 discuss the color feature extraction and description based on HIS. In section 3, we discuss the shape feature extraction and description base on Fourier descriptor operator. In section 4, we give the conclusion of this paper.

Edge Detection based on Canny Operator

The edge is the essential character of fruit image. Only with the edge detection from the original image, we can excute the subsequent processing. The basic principle of edge detection as follows: firstly, use the edge enhancement operator to highlight the local edge in the image; then difine the "edge strength" in pixels and extract the edge point set by setting the appropriate threshold.

It is commonly use some operators template and image convolution to detect the object edge. Typical operators template are Roberts, Sobel, Prewitt and Canny. In this paper, we use the four operators to detect the edge of orange image. The expriment results show as Figure 1.

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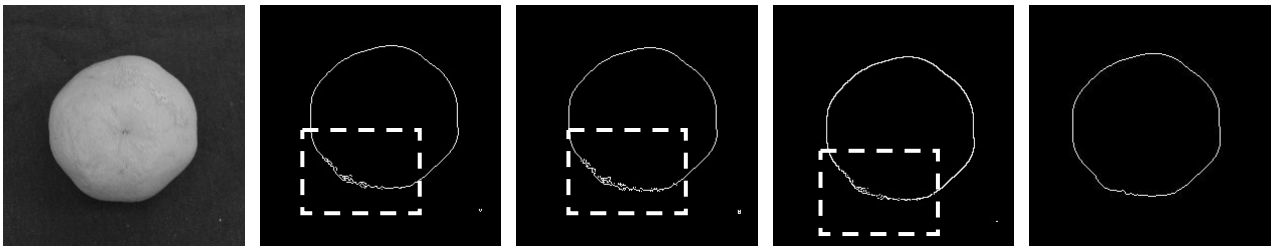

(a) (b) (c) (d) (e)

Figure. 1 The results of edge detection

(a) original image (b)Sobel operator (c)Prewitt operator (d)Roberts operator (e)Canny operator

Obviously, the Canny operator is the best. Because Canny operator is high SNR, high accuracy and low computation. Meanwhile, in orange images, the orange surface color tends to yellow, the backgroud color is deep blue and the texture of image is more obvious. So, we use the Canny operator to detect the edge of orange image. The Gauss smoothing filter of Canny operator in this paper describe as Equations 1, where $\sigma = 1.4$

$$\frac{1}{115}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} \tag{1}$$

Color Feature Extraction and Description based on His

$$I = \frac{1}{3}(R+G+B) \tag{2}$$

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

$$H = \arccos\left\{\frac{[(R-G)+(R-B)/2]}{[(R-G)^2+(R-B)(G-B)]^{1/2}}\right\} \tag{4}$$

When G≥B，0≤H≤180°, H can be caculate by Equation 4;

When G≤B，H>180°，H can be caculate by Equation 5;

$$H = 360° - \arccos\left\{\frac{[(R-G)+(R-B)]/2}{[(R-G)^2+(R-B)(G-B)]^{1/2}}\right\} \tag{5}$$

So we can simplify the equations as Equation 6：

$$H = \begin{cases} \left\{270^o + \tan^{-1}\left[\frac{2R-G-B}{\sqrt{3}(G-B)}\right]\right\} * \frac{255}{360} & G > B \\ \left\{90^o + \tan^{-1}\left[\frac{2R-G-B}{\sqrt{3}(G-B)}\right]\right\} * \frac{255}{360} & G < B \\ 255^o & G = B \end{cases} \tag{6}$$

Shape Feature Extraction and Description base on Fourier Descriptor Operator

We use the Canny operator to detect the edge of orange image in this paper. The orange edge mostly like a circle curve, can be expressd as $r(\theta)$ in polar coordinate system, where θ is the polar angle and r is the polar radius, and the edge of orange also can be defined as a periodic function like $r(\theta+2\pi)=r(\theta)$, where the period of function is 2π. According to the properties of periodic function, any periodic function can be expanded into the combine of different frequency components trigonometric functions based on Fourier series, show as Equation 7 and 8.

$$F(t)=a_0+\sum_{n=1}^{\infty}(a_n\cos(nwt)+b_n\sin(nwt)) \tag{7}$$

$$a_0=\frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}f(t)dt \qquad a_n=\frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}f(t)\cos(nwt)dt \qquad b_n=\frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}f(t)\sin(nwt)dt \tag{8}$$

Accrording to Euler formula, we can define Equation 9

$$F(t)=\sum_{n=-\infty}^{\infty}f_n e^{-jnwt} \tag{9}$$

Where f_n is the complex coefficient of Nth-degree harmonic, then we can get Equation 10 to Equation 12

$$f_0=a_0 \tag{10}$$

$$f_n=r_n e^{j\varphi_n}=(a_n-jb_n)/2=c_n e^{-j\theta_n} \qquad n\geqslant 1 \tag{11}$$

$$f_{-n}=r_{-n}e^{j\varphi_{-n}}=(a_n-jb_n)/2=c_n e^{-j\theta_n} \qquad n\geqslant 1 \tag{12}$$

Because F(t) shows as Equation 9 is a periodic function, we can excute DFT transform on the radius sequence of oranges, use the complex coefficient as Fourier descriptor operator.

Obviously, the radius of oranges are different from each other, so the F(n) we get from DFT transform can not be used directly, it must do the normalized process as Equation 13 and Equation 14.

$$r_p=\sum_{k=0}^{n-1}r(k)/n \tag{13}$$

$$r_g(k)=r(k)/r_p \tag{14}$$

Where n=180, r_p is the average value of orange radius, $r_g(k)$ is the radius after normalized process. So every orange can be compared regardless of its size. Then caculate as Equation 15

$$F(h)=\frac{1}{n}\sum_{k=0}^{n-1}r_g(k)e^{-j2\pi hk/n} \qquad h=0,1,2,\ldots,n/2-1 \tag{15}$$

Where n=180. It can be proved that thirteen F(h) is enough to represent the shape of orange.

Conclusion

In this paper, we discuss the fruit feature extraction and description method. According to the characteristics of orange image, based on the analysis of some calculus operator in edge detection,

design an orange image edge detection method based on Canny operator. On this basis, combined with human visual characteristics, design color characteristics description methods based on HIS model and shape characteristics description methods based on Fourier descriptor operator. The experiment result proof that Canny operator is high SNR high accuracy and low computation; HIS model is more accord with human vision and low computation also; shape characteristics description methods based on Fourier descriptor operator is more easy to shape classification.

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