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The research of detecting method on crackled Chinese date based on chrominance components

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ABSTRACT

The crackle color of Chinese date in full ripe stage are similar to the normal ones and not be readily detected., so a new method is put forward based on chrominance component for detecting crackle. Obtain respective color space images of cracked Chinese date; Cut out two images in the normal area and five images in the cracked area of chrominance components; Calculate luminance average value and luminancerange and standard square deviation to screen preliminarily parameters. The result is R in RGB color space and C in CMY color space; Do experiments with 108 Chinese dates including 78 crackled dates and 30 normal dates. The result show that R is superior to C. Use the adaptive threshold value method to draw a complete crackle including noise, adopt the median filtering method to eliminate tiny noise, employ regional labeling remove big noise to catch the right crackle. The correct recognition rate of crackled dates is 89.7% and the false positive rate is 3.3%, which can basically meet the accuracy requirement of Chinese red dates grading system.

KEYWORDS

Chinese date; Chrominance component; Crackle; Detection.

INTRODUCTION

Red jujubes dehiscent fruit naturally or by mechanical compression in long-term growth process, causes the skin appearing a long break of more than one tenth of the crevasse that is crack. If the crack discoloration caused by mildew easily lead to bacterial invasion, but also caused excessive loss of water affecting the appearance quality. The red jujube grading mainly adopts artificial classification and grading simple machines. Artificial classification is easily influenced by subjective factors, simple mechanical classification generally only size grading, and of such as color, shape, defect inspection need to rely on other means[1,2]. The use of machine vision to detect cracks in agricultural products has made considerable progress[3-14]. Based solely on the chrominance component for crack detection algorithm are: Zhao Wenjie etc.[15] in the HIS color space, extract the red jujube color characteristic value of H mean and mean square error. Use support vector machines to identify defects jujube, oil head jujube, starch jujube, mildew jujube. The experimental results show that the recognition accuracy can reach 96.2%. It is better than 89.4% of artificial neural networks. Xiong Lirong etc.[16] use color characteristic parameters and gray scale threshold for image segmentation to extract six geometric parameters of the crack region and the noise region after dividing, which is used to recognize duck crack. Yang Xu[17] first used component image of Lab color space L, with automatic threshold segmentation cracks and dirt out of eggs characteristics, using the value of the 3 × 3 operator to filter out interference filter characteristics. And then use the Laplace contour extraction crack, crack the final image is obtained.

The crackle color of red jujube in full ripe stage are similar to the normal ones and not be readily detected, so a new method is put forward based on chrominance component for detecting crackle. First, each chrominance component separately obtain the brightness mean and range of red jujubes normal parts and crack parts. Choose chrominance components to extract more complete crack contain noise by adaptive threshold method. And then use filtering methods to remove small noise, with regional labeling remove large noise points. Finally, using this method extract features only contain cracks.

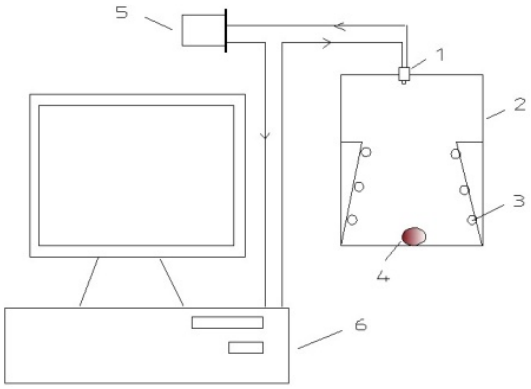
MATERIALS AND METHODS

Test material

Test samples chosen Agricultural Division of Xinjiang Production and Construction Corps jujube cultivation base ten groups planted Junzao required for ripening of jujube, a total of 108. It includes crack and no crack jujubes. Visual inspection system using a sample image acquisition res jujubes were obtained 108 images.

Image acquisition system construction

The red jujube self-designed machine vision inspection system in this paper shown in Figure 1.



1. CCD Camera 2. Light Box 3. Illuminant 4. Red Jujube 5. Image Grabber 6. Computer

Figure 1 : Red jujube image acquisition system

The system consists of camera 1, frame grabber 5, computer 6, illuminant 3, lighting box 2. White high-frequency fluorescent lamp as illuminant, power is 8W, 4 per side. Symmetrical illuminant were distributed in the interior light box all around. The angle of lamp and horizontal is 75 °. Boxes coated with milky white paint walls, a bottom covered with A4 paper.

Image grabber uses by OK- RGB10B chrominance RGB component acquisition card of Beijing JiaHeng Image Technology Company, which is installed in the computer based on the PCI bus architecture. The camera uses OK- AC1300 high resolution chrominance CCD camera the of Beijing JiaHeng Image Technology Company. Field range is 672×519mm. Adjust the camera's shutter to 1 / 500s, using a frame rate of 15 frames per second. The PC machine is Lenovo type, CPU is PIV, memory is 256MB, and hard disk capacity is 40G. Image processing platform is Matlab7.0.4.

Manual inspection method Red jujube crack

Natural dehiscent fruit formation of the cracks mainly straight and curved, shallow cracks. Crack caused by mechanical damage have T or other multi-branch crack, which is generally darker. Crack part colors usually more dark than normal part. Figure 2 shows the different crack types image of red jujube.

(a) Single Straight Crack (b) Single Diagonal Crack

(c) T crack (d)Multi-branch crack

Figure 2 : Images of crack types on red jujube

Take the test samples for manual inspection in natural light, the test results as: crack jujubes are 78 grains and no cracks jujubes are 30 grains.

CRACK DETECTION METHOD

Crack extracted chrominance components preliminary screening

In each chrominance component, red jujube normal part is different in the extent of the crack part of different brightness. In order to facilitate the extraction of the selected portion and choose the larger difference chrominance component between normal and crack part as the feature candidates extracted components.

Brightness mean difference between the sample reflects the degree of difference between classes., The sample standard deviation reflects the degree of dispersion of samples within the class. The smaller the value, the lower the likelihood of inter-class cross. For this selection of the sample mean and standard deviation as the brightness of the chrominance components screening index. Brightness expression for the mean and standard deviation

$$\overline{H} = \frac{1}{N}\sum_{i=1}^{N} H_i \quad \textbf{(1)}$$

$$\sigma_H = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(H_i - \overline{H})^2} \quad \textbf{(2)}$$

Where, *N*-target pixel sum

H_i-the ith pixel brightness value of the target

Due to the normal part of the area is small, red jujube crack part brightness distribution of a wide range. In order to make statistics can express the characteristics of the region, according to the convenience screenshot of random intercept five different size of crack area. It can cover the crack part, for the regional average brightness statistics, take the average brightness, which is the average brightness of crack part. Red jujubes normal part of the area is large, easy to sample, representative of the strong, so only random intercept two different image sizes normal region, covering 70% jujube normal port. Statistical methods are as follows:

1) Respectively random intercept crack jujube normal 2 parts area of each chrominance component of the basic cover red jujube normal part. 5 parts of crack area, the basic cover crack parts.

2) The statistical brightness of each chrominance component of the two normal mean and standard areas of the image jujube cracks differential. Statistics brightness of each chrominance component of the five jujubes mean and standard crack crack region of the image.

3) Calculate the mean and standard deviation of 2 crack jujubes the mean image brightness mean the normal region, the crack jujube as the overall brightness of each color component of the mean and the standard difference between the normal portion of the image. Calculate 5 crack jujubes crack region brightness of the image jujube mean and standard deviation of the mean average of a crack as a whole jujube crack part of the chrominance components of the image brightness and standard deviation of the mean.

4) Comparing the chrominance and brightness components of the overall mean of the normal part and the overall crack part. The larger the difference between the weight of the selected candidate, as the first component of crack detection.

Interception Figure 2 (a) a normal part of the image dates two regions, the image of a crack part 5 areas, as shown in Figure 3.

Normal 1 Normal 2 Crack 1 Crack 2

Crack 3 Crack 4 Crack 5

Figure 3 : Different parts in RGB image

Setting $\overline{H}_{10}$ is the brightness of the normal area of local red jujubes mean. $\sigma_{H_{10}}$ is the standard deviation for the region brightness. $\overline{H}_1$ is a normal part of the overall brightness red jujubes mean. σ_{H_1} is

the standard deviation for that part of the brightness. $\overline{H}_{20}$ is the local crack region red jujubes brightness for the mean. $\sigma_{H_{20}}$ is the standard deviation for the region brightness. $\overline{H}_2$ is the overall crack for dates part brightness mean, and σ_{H_2} is the standard deviation for that part of the brightness. H is $\left|\overline{H}_1 - \overline{H}_2\right|$. The statistical image of the above seven component of the brightness RGB mean and standard deviation, as shown in TABLE 1.

TABLE 1 : One gray statistical results of one crackled red jujube in RGB components

statistical areas	brightness parameter	R	G	B
normal	$\overline{H}_{10}$	141	71	67
Area 1	$\sigma_{H_{10}}$	0.005	0.005	0.005
normal	$\overline{H}_{10}$	144	73	67
area 2	$\sigma_{H_{10}}$	0.007	0.007	0.007
normal	$\overline{H}_1$	143	72	67
area	σ_{H_1}	0.006	0.006	0.006
crack	$\overline{H}_{20}$	85	52	54
area 1	$\sigma_{H_{20}}$	0.066	0.066	0.066
crack	$\overline{H}_{20}$	78	48	51
area 2	$\sigma_{H_{20}}$	0.052	0.052	0.052
crack	$\overline{H}_{20}$	97	53	51
area 3	$\sigma_{H_{20}}$	0.032	0.032	0.032
crack	$\overline{H}_{20}$	114	71	76
area 4	$\sigma_{H_{20}}$	0.067	0.067	0.067
crack	$\overline{H}_{20}$	98	54	53
area 5	$\sigma_{H_{20}}$	0.054	0.054	0.054
crack	$\overline{H}_2$	94	60	55
regional average	σ_{H_2}	0.054	0.054	0.054
brightness difference between class	H	49	12	12

Using the same method as a normal part of the interception jujube two normal regions, the area of a crack part is 5. Statistics 7 image brightness of each corresponding mean and standard deviation, each chrominance component in turn draw a normal part of the overall brightness red jujubes mean and standard part of the difference between the overall crack. Statistics The results are shown in TABLE 2.

TABLE 2 : The brightness of the crack jujube each chrominance component

serial number	chrominance space	chrominance component	$\overline{H}_1$	$\overline{H}_2$	*H*	preferred component
1	*RGB*	*R*	143	94	49	*R*
2		*G*	72	60	12	
3		*B*	67	55	12	
4	*rgb*	*r*	129	114	15	
5		*g*	65	70	5	
6		*b*	61	71	10	
7	*CMY*	*C*	112	163	51	*C*
8		*M*	182	201	19	
9		*Y*	187	198	11	
10	*lab*	*l*	181	166	15	
11		*a*	75	62	13	
12		*b*	66	54	12	
13	$I_1I_2I_3$	I_1	81	69	12	

14		I_2	74	36	38	I_2
15		I_3	0	0	0	
16	*YCbCr*	*Cb*	115	122	7	
17		*Cr*	159	146	13	
18	*YIQ*	*I*	43	21	22	
19		*Q*	13	8	5	
20	*HSV*	*S*	137	108	29	
21		*V*	140	96	44	*V*
22	*HSI*	*S*	76	52	24	
23		*I*	94	63	31	

As can be seen from TABLE 2, each of the chrominance space difference between the red jujubes brightness mean of the normal port and the different port of the crack. Where: the C component in CMY space of the mean of the brightness difference is 51, which is the largest. Followed by the R component, the mean of the brightness of the RGB space the difference is 49. The following sequence of V component, the difference is 44. I_2 component, the difference is 38. Set D_C, D_R, D_V, D_{I2} respectively represent mean the difference in brightness component class of C components, R component, V component and I_2 component, the sort of: $D_C > D_R > D_V > D_{I2}$. After statistical analysis, initial screening component C CMY space, the candidate parameter I_2 component, R component in RGB space, V component in HSV space, and I1I2I3 space as jujube crack feature extraction.

Crack secondary chrominance component extracting filter

Preliminary screening red jujubes for the above crack for Figure 2 (a) used to extract color components shown in Figure 4.

(a) C in CMY (b) R in RGB (c) V in HSV (d) I_2 in $I_1I_2I_3$

Figure 4 : Initial screening chrominance components images

Mean changes in the brightness range of the chrominance components to some extent reflects the degree of dispersion macro within the class of dispersion macro within the class. $\overline{gray}$ rang is the range of brightness variation. $\overline{std}$ is brightness standard deviation. Statistics of the above-described method can be the range of the brightness variation of the color components of a crack region candidate, the results shown in TABLE 3.

TABLE 3 : The first candidate chrominance component crack area brightness range

project	*C*	*R*	*V*	I_2
$\overline{gray}$ *rang*	33	30	46	21
$\overline{std}$	0.05	0.05	0.04	0.05
component	C	*R*		I_2

Set R_C, R_R, R_V, R_{I2} is the range of brightness for each chrominance component of the mean change candidate. As can be seen from TABLE 3, $R_V > R_C > R_R > R_{I2}$. As can be seen from Figure 4, the maximum brightness mean value for the range component is the V, and means that the component is in a larger degree of dispersion of the brightness of the crack. The crack is not conducive to the extraction, for the V component is removed from the candidate set in the component. Thus, the results of secondary

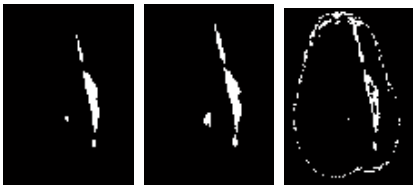
screening candidates for the chrominance components C component, R component and the component I_2.

Three screening of candidate chrominance components

Based on crack jujube candidate the brightness of the chrominance component of the normal part and crack part average variation range and the average brightness difference, adaptive double threshold method is used to extract crack characteristics test. Set *f(i,j)* to the original luminance value of the chrominance component of the image pixel at *(i,j)*, *g(i,j)* is the luminance value of the image pixel crack detection at *(i,j)*. "1" indicates crack region pixel value and "0" indicates the pixel value of the non-crack region. k is the brightness threshold adjustment. Algorithm is as follows:

$$g(i,j)=\begin{cases}0, & f(i,j)<\overline{H}_2-k\\ 1, & \overline{H}_2-k\le f(i,j)\le\overline{H}_2+k\\ 0, & f(i,j)>\overline{H}_2+k\end{cases} \quad \textbf{(3)}$$

The selection of k value will affect the accuracy of the extraction. k is too small, causing deterioration of the integrity of the crack extraction, k is too large, although a more complete extraction of the crack. But it will increase the noise too much complexity of the algorithm, the impact of the detection efficiency. Each component of the original image screening test to detect the crack, a large number of experimental results show that when the value of k is the ½ times of $\overline{gray}$ rang, the algorithm can obtain a more complete picture red jujubes cracks. Extraction shown in Figure 5.



(a) R Result (b)C Result (c)I_2 Result

Figure 5 : The candidate image chrominance component test results

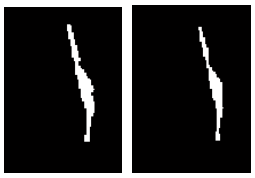
As can be seen from Figure 5, R component, C component comprising a majority of the detection results of a crack region in addition. There are some noises, mainly due to the sample itself causing the recess being squeezed aside a long time to cause false positives. This phenomenon can adjust the red jujubes by acquisition time and the detection time to avoid in order to reduce unnecessary calculations. In algorithm, it is also examining algorithm antinoise ability aspect of I_2 besides contain crack areas in the component test results. The edge produces a lot of noise, is not easy to remove from the candidate for this chrominance components concentration remove I_2. So far, three screening candidates chrominance components results are C component and R component.

Crack feature extraction

From Figure 5 the R component, C component of the test pattern can also be seen, the crack extracted part is still not continuous, two non-noise component contained in the crack part. So adjusting the value of k, will be double threshold range extended appropriately. A large number of tests showed that: when k = 12, the basic portion of the crack can ensure the extraction is continuous. The noise introduced but it would not do more processing.

Due to image contains multiple parts, of which the crack part is linear, the largest area. Small parts can use a 3 x3 filter operator filtering, median filtering by filter for noise elimination, the noise of the big points not to deal with. Crack extraction effect of the filter as shown in Figure 6 R and C component of the filter graph.

(a) R stickogram (b) C stickogram



(c) R figure after marking (d) C figure after marking

Figure 6 : The extraction results image on crackle

If there is a large crack in one red jujube, usually only a single crack. Based on this fact, with regional labeling of R and C component of the noise filter to remove large image point. By area of greatest argument for taking a crack, and the remaining part of the regional non-crack. Set S_i is the area of i th area of the labeled image, S is the area of the whole target image extraction. Algorithm is as follows:

$$S = \max\{S_i\} \quad \textbf{(4)}$$

A crack is detected by the above method, the extraction result shown in Figure 6.

As can be seen from the figure, the R and C component of the mark image can be extracted to a more complete cracking characteristics. But because of the diversity of the sample, the image acquisition system instability and non-uniformity of the light source and other reasons, to some extent, RGB image section will cause the image distortion. To enable screening of a representative chrominance component. And then take a crack red jujube as 49, the same chrominance component of the screening method. The final result is still integrated component and the R and C components. Needed to select the optimum components refer to the actual test results.

RESULTS AND ANALYSIS

Test results

This test method using the above 108 images for red jujubes crack detection, which cracked 78, no cracks 30, respectively statistics correctly identify cracks and crack-free accuracy and false positive rate. Statistics the results are shown in TABLE 4.

TABLE 4 : The testing result on crackle of red jujube

volunteers red jujube	chrominance component	crack unit is grain	no rack,unit is grain	accuracy rate /%	false positive rate /%
crack in 78 grains of jujube	C	72	6	92.3	7.7
	R	70	8	89.7	10.3
no crack in 30 grains of jujube	*C*	24	8	80.0	20.0
	R	29	1	96.7	3.3

Test analysis

As can be seen from the table, C component crack detection accuracy was 92.3%, but no crack detection error rate of the component is also high, reached 20.0%. The actual production is unacceptable, so C component was removed from the candidate chrominance component. R component crack detection accuracy rate is 89.7%, although lower than the C component, but its no crack detection error rate is very low, reached 3.3%. It basically meet the needs of the actual detection accuracy.

For the R component, the major reasons that affect the identification accuracy is due to a small number of red jujube samples themselves have undergone oxidation. The surface area of the normal darker color and abnormal regions close, resulting in the detection failure. Secondly, the light intensity of not uniform, it could lead to red jujubes edge color distortion, which is one of the reasons leading to the detection of false positives.

CONCLUSION AND DISCUSSION

This paper based on chrominance component to detect the red jujubes cracks, proposed crack identification algorithm based on chrominance component. The recognition accuracy rate for cracks is 89.7%, and the false positive rate is 3.3%. The algorithm for jujube varieties, fruit shape, stems are all sensitive, but the uniformity of the light source is more sensitive. Test proved that the method has certain theoretical significance and practical value for the detection of cracks detected red jujubes and other agricultural related indicators.

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