Application Research of Food Quality Detection Based on Computer Vision

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***Abstract*—It uses of computer vision technology to realize food quality detection by image analysis and extract the feature information of food from digital image. The localized power function mapping algorithm (LPFM) excels traditional ones in image enhancement effects for image with non_uniform brightness. This method has the advantage of high speed, high differentiation from image and lower background noise. The LPFM method plays a very good detection effect for food in the storage and transportation process.**

***Index Terms*—localized power function mapping algorithm, food quality detection, computer vision**

I. Introduction

In recent years, a variety of food safety problems have attracted extensive attention of the society, the Sanlu milk powder, Tonyred, Pomacea canaliculata, reassurance pork and other issues knoll the alarm bell of the food industry supply chain supervision.

Every consumer wants to buy health food and find enough food safety information. The computer vision technology for food safety monitoring is becoming more and more important to consumer health protection, social stability and economic development needs. Therefore, strengthen food quality monitor effectively has become the key to guarantee food quality and safety. The computer vision technology is made to realize communication between people and data, so that people can observe the data of food flow problems in the process and provide a powerful tool to solve the problem in time.

For various reasons, the food image with non - uniform brightness is more common. The food in the storage and transportation process is influenced by environmental factors; food images often showed uneven illumination, blur and contrast, which brought difficulty to diagnose or image processing, but the traditional method is difficult to get desired results. So it should be enhance the image quality by enhancing the local contrast of image. At present, the classical local enhancement algorithm has adaptive histogram equalization (AHE) and contrast inhibition of histogram equalization (CLAHE). We improve the AHE method, which divides the image into blocks and each of block histogram equalization, the final image gray value is decided from its adjacent sub-blocks interpolation. Karel Zuiderveld proposed the CLAHE method, it can effectively restrain background noise and redistributed histograms, the cumulative histogram growth (slope gradient) under control, effectively inhibit the noise which is brought by image contrast enhancement. But the CLAHE method also has its shortcoming when the contrast inhibition parameters get larger, the overall image contrast is greatly improved, but it will introduce a lot of noise. The image will be overall darker and go against distinguish if the contrast inhibition parameters change smaller.

Focusing on the defect of above method, this paper present a method for non-uniform brightness image enhancement by localized power function mapping algorithm(LPFM), it eliminates the noises by the "mean-variance" features.

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II. Local Power Function Mapping Method

A. Image Dividing Algorithm

We get the food images by computer vision, and then divide the image into $M \times N$ non overlapping sub-blocks, as showed in Figure1. Non overlapping region can effectively remove the grid effect by bilinear interpolation but the details in block frame have some degree of loss because it is not a complete sampling. It can make each sub-block gray mapping function is more reasonable through overlap region.

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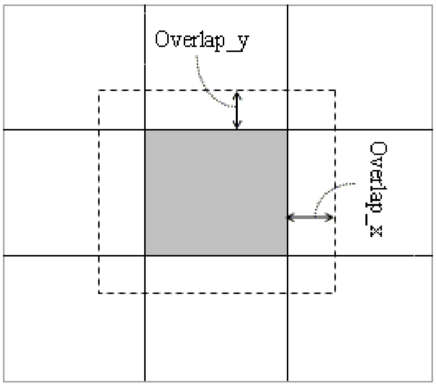


Figure1. Image sub-block and overlap windows

B. Getting Each Sub-block Gray Mapping Function

The most food image background is simple and the lower value of gray level and uniform distribution. We can give an effective judgment for the sub-block that determine whether the sub-block belonging to background.

(1)for the pure background areas, the mapping function is defined as in (1)

$$y=\frac{x_{Max}}{2^D-1}x, x\in[0,2^D-1] \qquad (1)$$

In formula (1), x_{Min} and x_{Max} are respectively pixel gray minimum and maximum value in the blocks.

The mapping function is equal to compress the target region gray range to the source region of the gray scale, which can effectively restrain noise and compare each area to homogeneous transition when gray-scale interpolation.

(2)the mapping function is defined as in (2)

$$y=\begin{cases}0 & 0\le x<x_{Min}\\ C\left(\dfrac{x-x_{Min}}{x_{Max}-x_{Min}}\right)^{\gamma} & x_{Min}\le x\le x_{Max}\\ 2^D-1 & x_{Max}<x\le 2^D-1\end{cases} \qquad (2)$$

C is mapping coefficient. For x-ray image, the C can be set to 2^D-1 in order to increase the brightness of the image and dynamic range. D is image bit number (let source and goal image have same bit number).

Gray mapping function is showed in Figure2. When $\gamma=1$, the linear mapping uniform tensions into the [0,255]; when $\gamma<1$, the tensile can increase the pixel contrast and brightness in a certain range; when $\gamma>1$, the tensile method can restrain a range of pixel contrast and brightness.

C. Bilinear Interpolation

The newly created pixel values in the target image are calculated by the weighted average of 2*2 regions of four adjacent pixel values around them from source image, it is showed in Figure3. The image quality is better after enlarging by bilinear interpolation algorithm.

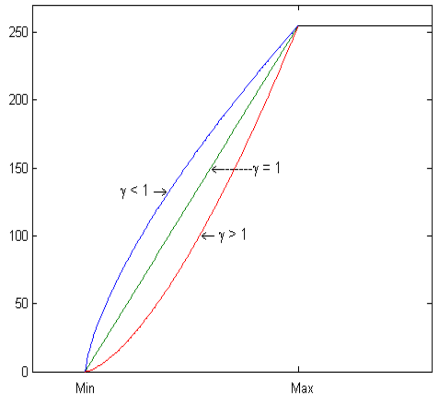


Figure2. Gray mapping function

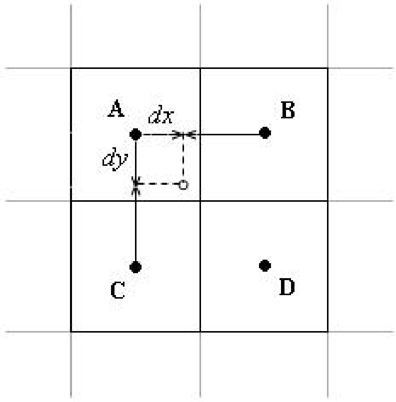
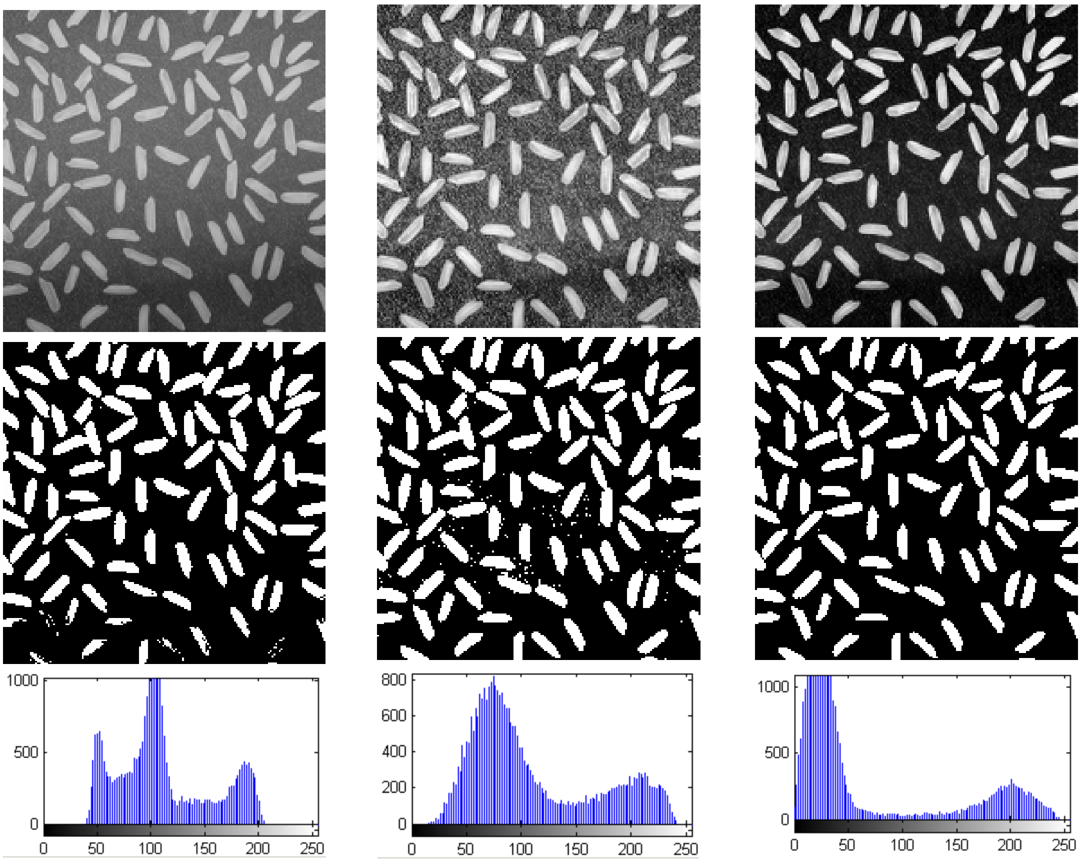


Figure3. Bilinear interpolation

In Figure3, supposing that the grey value of the interpolated point is s, the interpolation result s' is determined by four adjacent blocks as in (3).

$$s' = (1-\frac{dy}{ly})\left[(1-\frac{dx}{lx})G_A(s)+\frac{dx}{lx}G_B(s)\right] + \frac{dy}{ly}\left[(1-\frac{dx}{lx})G_C(s)+\frac{dx}{lx}G_D(s)\right] \qquad (3)$$

In formula (3), dx and dy are respectively horizontal and perpendicular distances between interpolated point and 'A' block center point. lx and ly are horizontal and perpendicular distances among the adjacent blocks. $G_A(s)$ 、 $G_B(s)$ 、 $G_C(s)$ and $G_D(s)$ are mapping values of the gray values s in the four sub-blocks



(a) original map (b) processing results by CLAHE (c) processing results by LPFM

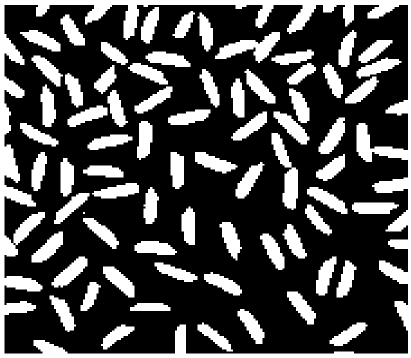
Figure4. Image processing algorithm of CLAHE and LPFM

We compare LPFM with classical algorithms such as CLAHE in Figure4: (a) is an uneven illumination image of the rice, and its histogram shows the irregular state in the three peaks. However, direct binarization of such images often results in unsatisfactory performance, it will inevitably lead to over segmentation; (b)is processing result by CLAHE algorithm, its histogram showed two peaks, Foreground and background have been distinguished, but because of the influence of background noise, the segmentation effect is still not ideal; (c) is processing result by LPFM algorithm, it has a good distinction from image and histogram that foreground and background of the rice image and get ideal result after direct binarization.

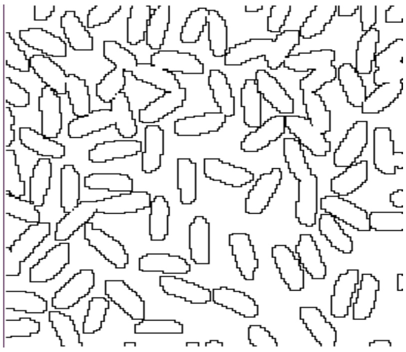
III. Object Contou r Extraction

The foreground and background of the image are very good classification in the image after LPFM processing but it has too many burrs at the edge of image, which will affect monitor effect of rice quality in the next step. We must further process of image to reach the purpose of rice quality detection. We process the images by the morphology image processing method in this paper.

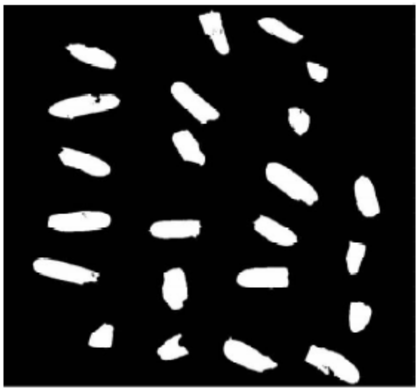
Morphology transformation of binary image is handling process based on set, the morphological operator expresses the interaction between set of object or shape and structuring element, and the shape of structuring element determines shape information of the extracted signal by this operation. The method of morphological image processing is moving a structure element in the image, and then computing the intersection, union of structuring element and binary image. The binary image after mathematical morphology processing laid a foundation for next shape recognition.



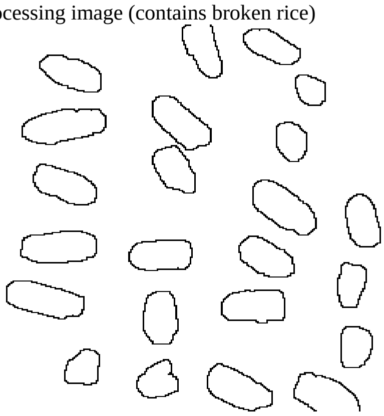
(a)LPFM processing image (not contains broken rice)



(b) Morphology processing image



(c)LPFM processing image (contains broken rice)



(d) Morphology processing image

Figure5. Rice contour extraction image

IV. THE SHAPE OF THE OBJECT RECOGNITION

Usually, Rice shape is close to elliptic curve, the recognition method looks the ellipse as a reference template and investigation of matching degree between target edge and ellipse. It has first determined ellipse template parameter. $\frac{1}{2}D_{max}$ is the major semi-axis a of ellipse, short half axis b and a are set perpendicular to one another, then

$$a=\frac{1}{2}(R[0]+R[180]),\quad b=\frac{1}{2}(R[90]+R[270]).$$

We use an array of L[] records distance from ellipse to the edge, elliptical polar coordinate equation is showed as in (4)

$$r=\frac{1}{[(\frac{\cos\theta}{a})^2+(\frac{\sin\theta}{b})^2]^{\frac{1}{2}}} \tag{4}$$

In formula (4), $\theta_j = j\times\pi/180$, $j\in[0,359]$.

In order to contrast the similar level of target and ellipse, we must calculate the related coefficient C between $L[]$ and $R[]$:

$$C=\frac{\sum_{j=0}^{359}R[j]-\overline{R})\bullet(L[j]-\overline{L})}{[\sum_{j=0}^{359}(R[j]-\overline{R})^2]^{\frac{1}{2}}\bullet(\sum_{j=0}^{359}(L[j]-\overline{L})^2]^{\frac{1}{2}}} \tag{5}$$

$\overline{R}$ and $\overline{L}$ are $R[]$ and $L[]$ average values:

$$\overline{R}=\frac{1}{360}\sum_{j=0}^{359}R[j]\quad \overline{L}=\frac{1}{360}\sum_{j=0}^{359}L[j]$$

They represent the target closer to ellipse while C closer to 1

V. EXTRACTING FEATURES

(1) Determining pixels threshold of circumference of rice. We follow the contour feature extraction algorithm to extract the number of pixel points of the average circumference, then according to the average value of the contour pixel, we determine threshold T of circumference of rice.

(2) Judging the quality of rice. When rice circumference less than threshold T，it explains the rice is broken or other material. Through the feature extraction we can identify a number of rice as in Table1.

Table 1 Recognition results of rice kernel shape

Rice Type	Test/ Rice Kernel	accuracy rate/%
Whole grain rice	150	97.1
Broken rice	130	91.7

VI. CONCLUSION

The paper presents the method that it obtained better effect of image enhancement than traditional CLAHE method. It is not difficult to get the ratio of rice, and then divide by the total rice and get rice milled rice rate, provides data for rice quality. The experiment proved that the recognition technique based on computer vision can satisfy the demand of rice detection rate, so this method has a great application potential in food quality detection field.

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