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The shape recognition of agricultural products and invariance analysis based on simulation of optical correlation recognition

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ABSTRACT

At present, a method of computer simulation of the optical joint transform correlation is widely used in the fingerprint identification but rarely in the agricultural products detection. This paper introduces theory of the optical correlation recognition,simulates by Fourier Transform and choose the maximum sidelobe as the feature to recognize the shape of agricultural products. Take the potato for example,the paper test the feasibility of the algorithm and verify the invariance. This algorithm is easy and feasible, has the invariance of translation, scaling and rotating(a small azimuth angle range). With low requirement of image and rapid calculation,this method can be widely applied in the shape recognition of many agricultural products.

KEYWORDS

The simulation of optical correlation recognition; Quality detection of agricultural products; Shape recognition; Invariance Analysis.

INTRODUCTION

The detection technology based on the simulation of optical correlation recognition has widely used in multidisciplinary field, such as character recognition, fingerprint identification, industrial automation monitoring and so on[1-5]. Though to simulate the optical theory with computer has become one of the focuses in the field of machine vision at present, there has been little internal research on the quality detection of agriculture product based on this theory. At present, the method used for shape detection can be divided into two types: based on edge and based on region. For feature selection, these complex methods are mainly on the fourier transformation and moment feature, which has high demand for image and low speed[6,7]. While, some simple methods are not suitable for out-of-shape products detection.

In order to explore the feasibility of simulation theory of optical correlation transform in the agriculture product's quality detection and the influence of the image transformation for results, this paper simulate the optical correlation recognition in MATLABR2008a and analyse the feasibility and the invariance of the algorithm.

THE ALGORITHM OF THE OPTICAL CORREATION TRANSFORM

For the complicated optical experimental process and the high demand for the experimental conditions, it is difficult to complete physical testing in the laboratory[8,9]. While to simulate the optical experimental in MATLAB is easier, in which has a strong engineering computing ability and a lot of image processing function.

The algorithm realization of the optical correlation recognition

Taking the potato for example, to simulate the process of optical correlation transform that applying for product shape detection are as follows, shown in Figure 1.

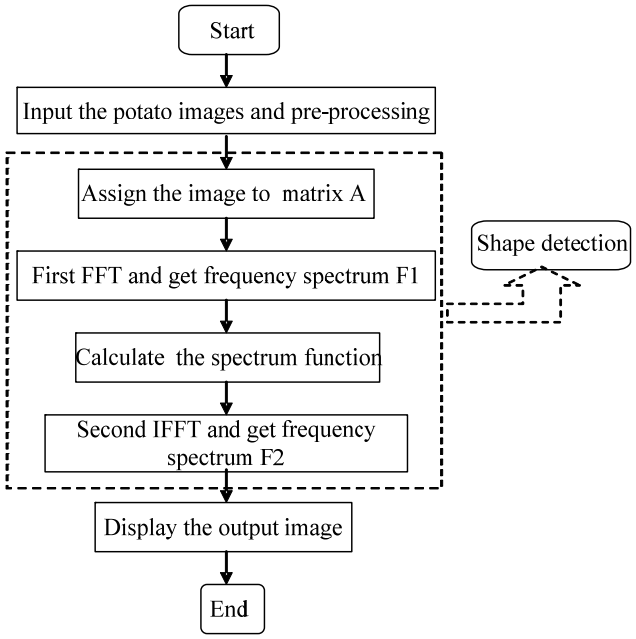


Figure 1 : Flowchart of the Optical transformation algorithm used in potato shape recognition

First, the potato image was processed by filter and gray-scale transformation and other pretreatment methods. Secondly, the image to be measured and the image with given shape axisymmetric are laid and are stored as a new image in JPG. Assign in the matrix A as the image grey value, in which set the color of background white and grey value is one. The image division and feature selection could be realized by adopting threshold division technology. Thirdly, calling the function of two-dimensional discrete fourier transform to get the spectrum function F(include magnitude and phase spectra)of the pretreatment image. And performing *F*(include magnitude and phase spectra)of the pretreatment image. And performing odulo *F can get the power spectrum*. Finally, calling the inverse fourier transform function and doing Spatial filtering process, then a sidelobe peak function can be got, which formed in the related joint transform indicates potato similarity.

The auto-correlation peak of the measured image *(t)* and the cross-correlation peak of the reference image *(r)* are shown in the diagram of the output function. If the image r and t have the same or similar shape, the association point is bright and the peak is high. In opposite, if the image *r* and *t* have a very big difference, there is a dark blur-circle-diameter and the peak is low. Therefore, according to the difference of the correlation peak or set a threshold for the function can the image recognition[10].

Shape feature selection

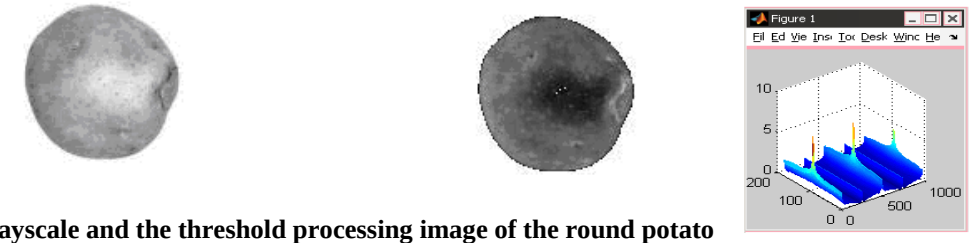
For comparison and analysis of the feasibility and accuracy of the algorithm, the potato existing sample images were divided into three categories in this paper, namely, round potatoes, oval potatoes and deformed potatoes. Because the algorithm is neither based on region nor based on the edge, but the results of recognition were displayed by spectrum, therefore, it has nothing to do with the resolution of the potato, so this article dealt with the picture resolution of 240 * 190, the background is white, the gray value is 1, after comparison we found that to reduce post-contrast image resolution does not affect the recognition results, while reducing the actual amount of computation to identify faster. Main lobe peak in optical correlation recognition power spectrum indicates that the autocorrelation degree between reference images and test images, side-lobe peak represents the cross-correlation degree between reference images and the test image. Therefore, this study choose the side-lobe peak as the basis to evaluate the potato shape similarity.

FEASIBILIT AND INVARIANCE ANALYSIS

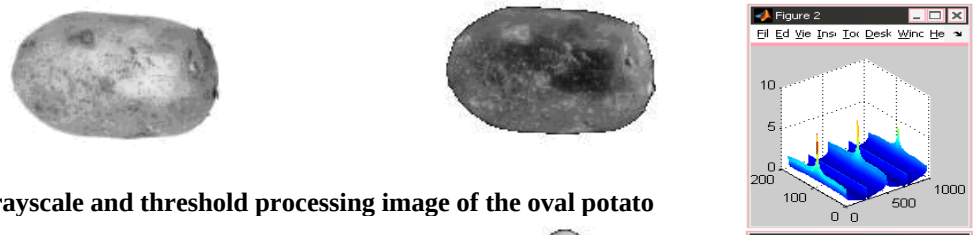
Experiments were performed to compare the feasibility and the invariance of the following two situations: one is carried out each potato shape similarity among same species; another is to identify each potato shape similarity between the different type.

Experiment of the same type potatoes

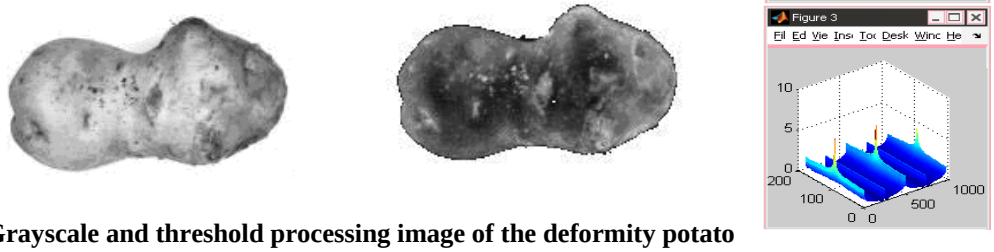
Taking a image from the given type for test and illustrating as each shape with one analysis image. After gray-processing and threshold processing The feature information of each type image are shown as Figure 2 blow. After simulation of optical correlation recognition, the auto-correlation peak refered to images of Figure 2 are shown at the right side. We can see the three peak diagrams are quite similar, the mainlobe and side lobe are both very sharp and have very high peak value. After the result contrast analysis, simulation of optical correlation recognition between sample image with itself, the autocorrelation or crosscorrelation will has very high peak value.



(a) Grayscale and the threshold processing image of the round potato



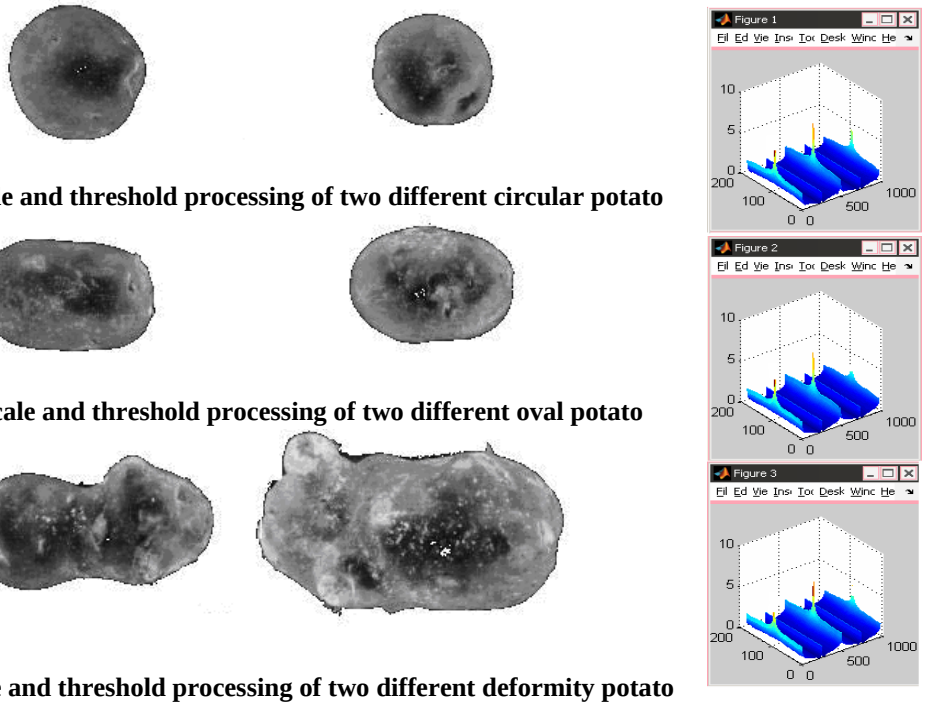
(b) Grayscale and threshold processing image of the oval potato



(c) Grayscale and threshold processing image of the deformity potato

Figure 2 : Grayscale and threshold processing of sample potato and the result of simulation of optical correlation recognition between sample image with itself

Then two images were respectively selected for each test from the circular, oval and deformed image of the sample library of potato, i. e., the joint transform correlation was carried out between categories of shapes with different images, the gray-scale image of the image whose threshold value is set to 0.95 and characteristics were extracted was shown in Figure 3. The result of the transformation of the shape of the same kind but different potato images we obtained was shown at the right side. As can be seen from the figure showing the shape of the three pieces of the correlation peak is also somewhat similar, the main lobe of the spectrum also has a high peak, although the side-lobe peak is not as high as image itself, the peak is relatively high. Through the analysis of the results, we obtained: after the optical correlation recognition between images in the same category, it has a relatively high cross-correlation peak.



(a) Grayscale and threshold processing of two different circular potato

(b) Grayscale and threshold processing of two different oval potato

(c) Grayscale and threshold processing of two different deformity potato

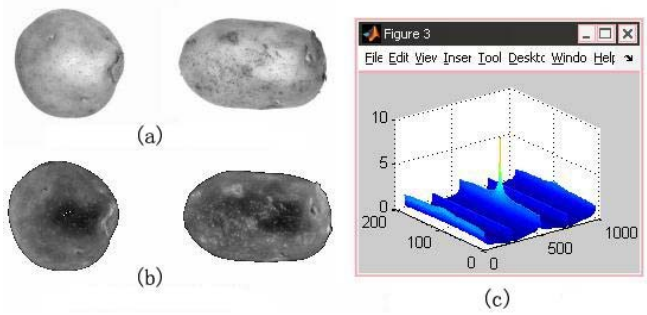
Figure 3 : The threshold processing of different potato in same classes and the result of simulation of optical correlation recognition between different potato image in the same classes

The two cases show that, when the shape of the potato belonging to the same category of the images are conducted under optical correlation recognition, the side lobe peaks will be higher.

Experiments for different type shape of the potatoes

The contrast experiment of optical correlation recognition between round potatoes and oval potatoes, deformed potatoes and oval potatoes, round potatoes and deformed potatoes respectively.

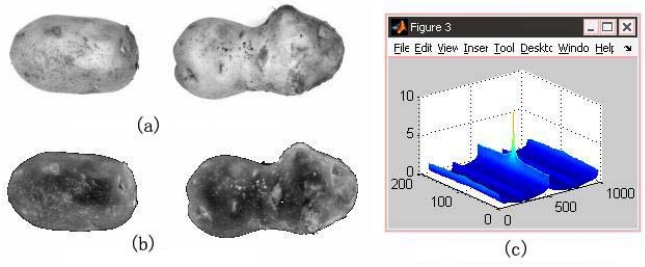
First,separately selecting a image of a round potato and one of an oval potato, and then doing simulation of optical correlation recognition, we can get their grayscale images, feature images after the gray threshold extracted and the output of optical correlation recognition, such as Figure 4(a) to (c). Through the analysis of the results, we found that the peak value of cross-correlation of the potatoes images is very small.



(a) Gray image of the round and oval potato (b) Grayscale and threshold processing image (c)Result of simulation of optical correlation recognition

Figure 4 : The simulation of optical correlation recognition of round and oval-shaped potato image

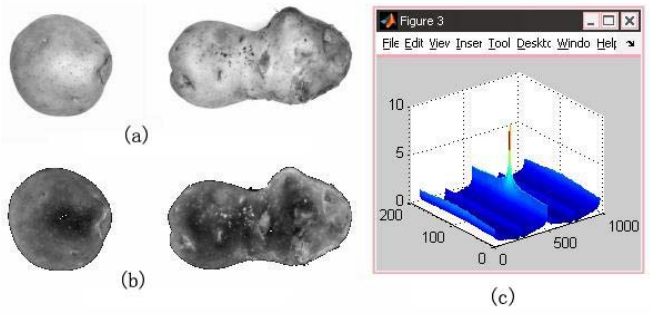
Second, separately selecting a image of a deformed potato and one of an oval potato, and then doing simulation of optical correlation recognition,we can get their grayscale images, feature images after the gray threshold extracted and the output of the optical correlation recognition, such as Figure 5(a) to (c). Through the analysis of the results, we found that the peak value of cross-correlation of the potatoes pictures after the transformation is also very small.



(a) Gray image of the oval and deformity potato(b) Threshold processing image (c) Result of simulation of optical correlation recognition

Figure 5 : The simulation of optical correlation recognition of the oval and deformity potato image

Third,separately selecting a image of a round potato and one of a deformed potato, and then doing simulation of optical correlation recognition, we can get their grayscale images, feature images after the gray threshold extracted and the output of the the optical correlation recognition, such as Figure 6(a) to (c). Through the analysis of the results, we found that the peak value of cross-correlation of the potatoes pictures after the transformation is very small, too.



(a) Gray image of the round and deformity potato(b)Threshold processing image(c) Result of simulation of optical correlation recognition

Figure 6 : The simulation of optical correlation recognition of round and deformity potato images

From the three experiments above, we can see that when the simulation of optical correlation recognition was done for different shapes of potatoes, the sidelobe is a diffuse spot and peak value of cross-correlation is so small.

So when the images of agricultural products to be tested and a certain number of sample images which their shape categories were known in image gallery were done the simulation of optical correlation recognition, the shape categories of the products can be defined by the peak value of the sidelobes with setting the threshold. The feasibility of this algorithm is better.

INVARIANCE EXPERIMETS AND ANALYSIS

Selecting a picture of a round potato as representative, then making its grayscale image translated, rotated for different angles and scaled by different scales, and then doing simulation of optical correlation recognition separately with self-image, sample images in the same category and sample images of different types, we can find out the influences of image transformation effecting on testing results.

Comparative experiments for shifting invariance

When the image shift horizontally or vertically for a certain distance, it's pixels, gray information and shape will not change. So this does not affect the detection results of algorithm. It has a characteristic of shifting invariance.

Comparative experiments for scaling invariance

Making the grayscale image scaled by 0.5, 1.5 and 2.0, the original grayscale images and the images after scaling are shown as Figure 9(a) to (d). Doing simulation of optical correlation recognition separately using the potato images after scaling, like Figure7 (b) to (d), and the original potato images, we can get the correlation peak value figure. The figures show that they have the great peak values with the original images. When using the scaled images to do the shape recognition, the experiments results show that no effect on shape recognition result. So this algorithm has a characteristic of scaling invariance.

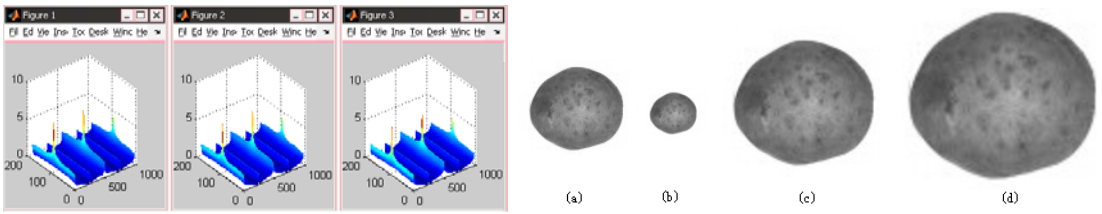


Figure 7 Scale transformation of the potato image and result of simulation of optical correlation recognition of scale-transformation and original image

Comparative experiments for rotation invariance

Making the potato images rotated clockwise for 15°, 30°, 45°, 60°, 90°and 180°, such as Fig.8 (a) to (f). Doing simulation of optical correlation recognition separately using each image and the original no rotated potato image, we can get the correlation peak value figure. Then classified determining the rotated potato image sidelobe peak values according to the setting category threshold value, we found that the potato shapes of rotated by 15°, 30°, 45°and 60°were still defined as round, but of rotated by 90°and 180° were wrong.

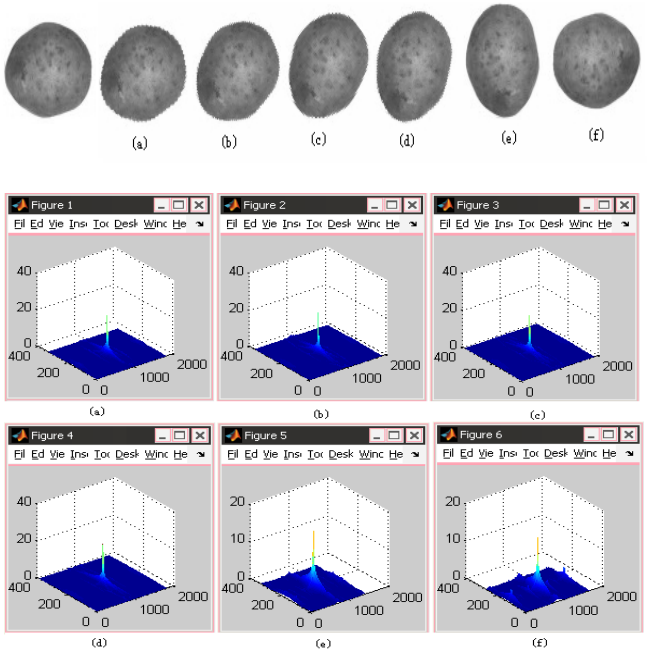


Figure 8 : The rotated-image of potato and the result of simulation of optical correlation recognition of rotated-image and original image

So this algorithm can meet the rotation invariance when the images rotation angle is small. If the agricultural product shapes vary greatly in the three-dimensional images, that is, the dynamic detection of agricultural product would cause wrong judgment because of the inappropriate image acquisition angle during the potato rotating.

CONCLUSIONS

Using computer to simulate the optical correlation recognition process, the algorithm is simple, the experimental comparison shows that to use the optical correlation recognition to acquire the peak of side-lobe to determine the threshold is an effective method for shape recognition about agricultural products, and the algorithm which is for the image shifting, scaling and rotation of the small scale range is invariant, convenient and simple, recognition speed is fast, lower requirements of the image to meet the requirements of an efficient real-time detection. If the algorithm of this study was improved about the impact on the recognition results when the angle of rotation of the image is larger in the future, it would be a very practical feature recognition method, which will play an even greater advantage in the industrial and agricultural production.

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