Research on rice grain detection method based on MATLAB image processing

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Abstract: In order to solve the problems of low accuracy of manual counting and long time-consuming photoelectric methods such as grain counting instrument in the process of paddy grain detection, the computer vision system and MATLAB software development platform are used instead of manual paddy grain detection for automatic detection. The algorithm uses spatial filtering of rice grain images to remove noise “Otsu” method for optimal global threshold segmentation of the image, based on the image processing to complete the determination of the number of rice grains, grain size of the two indicators. Four varieties of rice, namely, 'Wuchang Rice', 'Indica Rice', 'Japonica Rice' and 'Founder Rice', were used as experimental subjects. object, to study the determination of the two indexes of rice grain counting and rice grain size grading. The experimental results show that the algorithm and the program are accurate and effective, can accurately calculate the number of rice grains, and the algorithm and the program can accurately and effectively determine the size of rice grains. The algorithm and program to determine the average area size of each variety of rice particles and 100-grain weight into a positive correlation, and the coefficient of determination is 0.91965, the algorithm and program can accurately and effectively determine the size of soybean particles. In short, based on the research of MATLAB image processing rice grain detection method can relatively reduce the labor intensity of human labor and the lack of human vision, in improving the efficiency and accuracy and other aspects of the work of the important significance.

Keywords: computer vision image processing; rice grain counting; rice grain size; MATLAB

Introductory

As one of the most important food crops in the world, the yield and quality of rice are directly related to global food security and economic development. During the production and processing of rice, accurate and efficient detection and evaluation of rice grain is an important part of ensuring the quality of rice [1]. Traditional rice grain detection methods mainly rely on manual observation and simple physical measurements, which are not only inefficient, but also susceptible to the influence of human factors, making it difficult to ensure the accuracy and reliability of the detection results.

With the rapid development of computer technology, image processing technology is widely used in the field of agriculture, through the image processing technology, the non-contact detection of paddy grain can be realized, avoiding the interference of human factors in the traditional methods, improving the detection efficiency and accuracy [2], providing new ideas and methods for the detection of paddy grain.As a powerful mathematical computation software, MATLAB, with its strong image processing and data analysis functions, provides a powerful tool for rice grain particle detection, which can further explore the potential information of rice grain and provide more scientific guidance for the production and processing of rice [3]. Therefore, based on MATLAB image processing technology, this study conducted an in-depth research on the rice grain particle detection method, so as to provide a more accurate and efficient detection method for the production and processing of rice, and improve the quality and yield of rice. At the same time, it can also provide a reference and reference for the detection of other food crops, and promote the scientific and technological progress and development in the field of agriculture.

1 Materials and methods

1.1 Experimental material

The rice samples 'Wu Chang Rice', 'Indica Rice', 'Japonica Rice' and 'Founder Rice' were obtained from Wuhan Light Industry University College of Food Science and the humidity was the same for all four rice varieties.

1.2 Collecting pictures of rice grains

Spread the rice evenly on the surface of the light box, making sure that the grains are separated from each other. A camera was used to take images of the rice grains and a computer was used to process the rice grain images. It was also ensured that the position of the camera was the same each time the camera was taken and that the size of the image was 1084 mm × 1924 mm (Fig. 1).

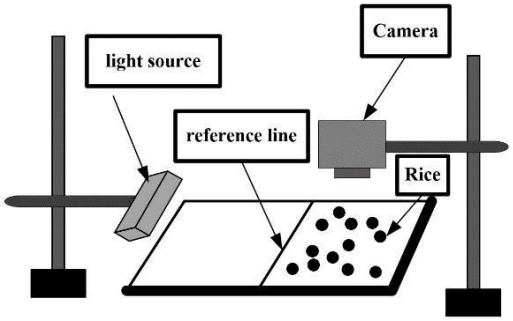


Fig.1. Schematic of rice grain image acquisition

1.3 Counting the number of rice grains

MATLAB digital image processing technique refers to the technique of processing and analyzing digital images in various ways using MATLAB software [4].MATLAB is a programming language widely used in scientific computing and engineering fields with powerful data processing capabilities and image processing toolbox. Various image processing operations such as image enhancement, filtering, edge detection, morphological operations, image segmentation etc. can be performed using MATLAB [5].

The counting and size assessment of paddy grains is carried out on MATLAB 7.0 software platform. First, a series of preprocessing steps need to be performed on the color image containing rice grains. The color image was converted to grayscale image for subsequent processing using MATLAB's built-in rgb2gray function. In order to remove the noise from the image, median filtering is applied to the grayscale image using the medfilt2 function. Next, global threshold segmentation is performed on the grayscale image using the "Otsu" method. The Otsu threshold is calculated by graythresh function and the gray scale image is converted to binary image using logical index or im2bw [6]. In binary images, rice grains are usually represented as white areas with black background. Since MATLAB 7.0 may not have direct morphological reconstruction functions, erosion and expansion operations can be used to simulate the effects of morphological reconstruction, but this usually requires more complex custom scripts [7]. The bwlabel function is used to find connected regions in a binary image, i.e., rice grains. The function returns a label matrix where each unique label corresponds to a connected rice grain. For each connected region, properties such as area and bounding box dimensions can be measured using custom scripts or functions in the MATLAB image processing toolbox (e.g., the equivalent function in regionprops) [8].

The total number of rice grains can be obtained by counting the number of unique labels in the label matrix. The area of each rice grain is obtained by accumulating the number of pixels in each connected region [9]. Then, the total area is obtained by adding the areas of all regions. By dividing the total area by the total number of rice grains, the average size of the rice grains can be obtained. Finally, this information can be used for size assessment of rice grains. Based on the calculated

average size, the rice grains can be categorized in terms of size or assessed for overall quality.

1.4 Software process

This experiment uses the image processing tools in MATLAB to process the target image.MATLAB image processing tools provide an integrated environment to improve the efficiency of processing data.Efficient programming can effectively perform complex calculations.MATLAB provides a powerful data visualization function that can help users to easily display and debug image processing results[10].

The flowchart of rice image processing is shown in Fig.2.

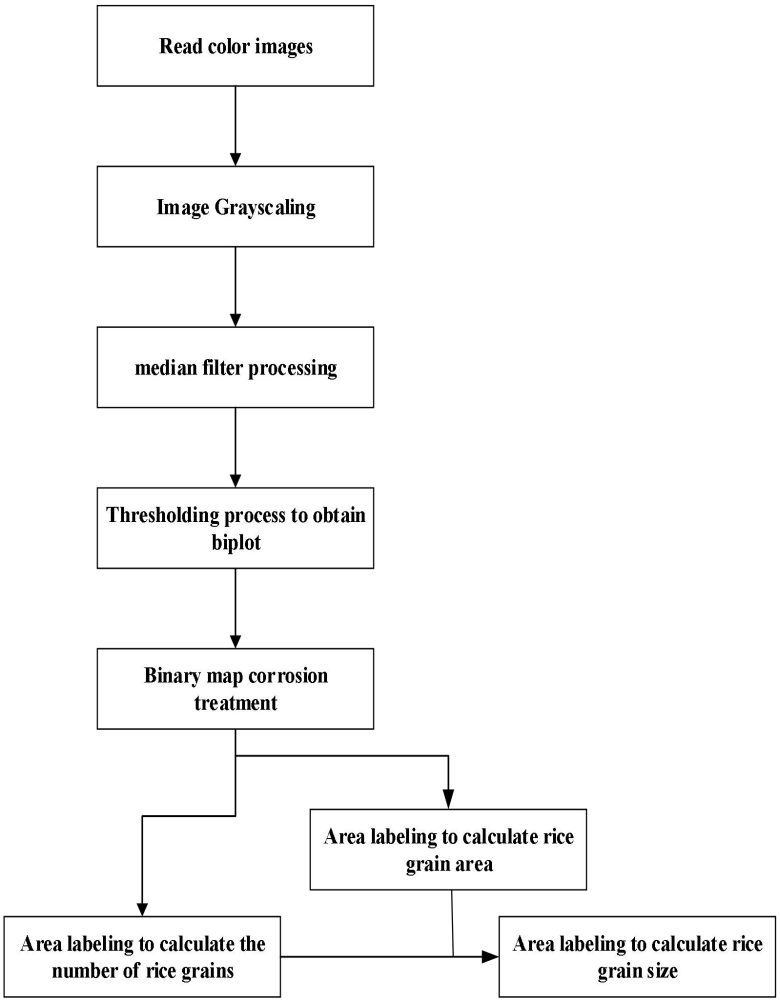


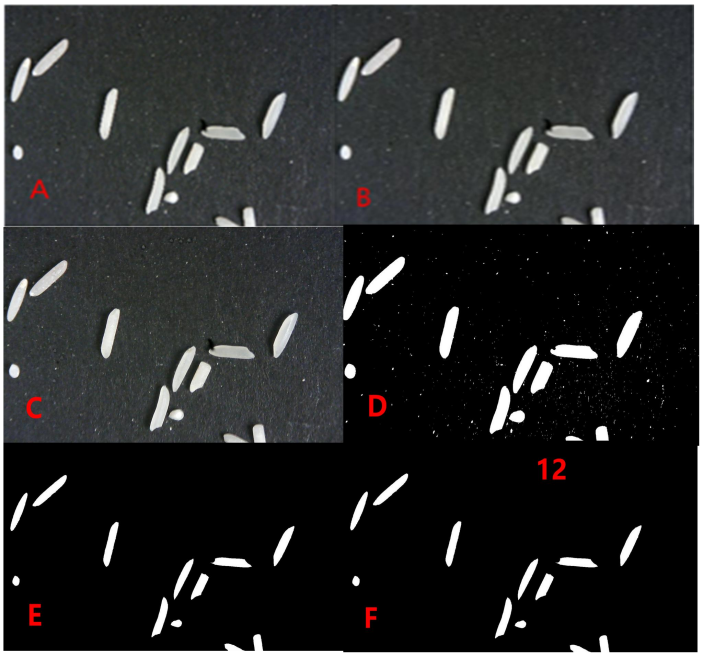
Fig. 2. Flowchart of paddy image procession

2 Results and analysis

Taking 'Wuchang rice' as an example, it can be seen from Fig. 3 that in order to count the single rice grains and obtain the average size of the rice grains, the single rice grains were preprocessed using the MATLAB software platform, which included grayscaling (Fig. 3B) of the color image (Fig. 3A), followed by median filtering [11]. In the threshold transformation process, the "Otsu" method was utilized to find an optimal threshold value through the graythresh function, and global threshold segmentation was performed (Figure 3C). After that, the grayscale image is converted to a binary image by im2bw function (Fig. 3D), and due to the presence of interfering clutter in the binary image, the binary image is corroded (Fig. 3E) in order to obtain the number of rice grains and the area of rice grains in the image [12].

The used bwlabel function is used to calculate the number of connected areas in the binary image and Area function is used to calculate the number of pixel points in each connected area by calling the function num=size(area) to count the total number of pixels. answer(1,1:num(2))=area(1:end) function is used to store the number of pixel points in each area of the black connected area, the run results in a total area of 16453 for the rice particles, the function cumsum(answers) accumulates the values in the array therein to calculate the total area of the black area [13].

In order to get the number of rice particles in the picture, first of all, the system recognizes the number of image connectivity map in the picture by calling the function bwlabel to assign the number of image connectivity map to the matrix L, regionprops(L) to measure the attributes of each labeled region in the labeling matrix, and return the value of the length of each labeled region to assign to the array stats[14]. Finally, the function Centroid is called to get the center of gravity of each region, and according to the statistics of the number of centers of gravity of each connected picture, the number of rice can be counted as 12 (Figure 3F). In order to get the average size of the rice grains in the picture, the average area size of the rice can be obtained as 1371.08 by calculating the ratio of the total area to the number of pieces.



A. 'Wuchang rice' original image; B. 'Wuchang rice' grayscale image; C. 'Wuchang rice' "Otsu " processed image; D. 'Gochang rice' binary image; E. 'Gochang rice' binary corrosion processed image; F.'Gochujang rice' number of

Fig. 3. Process diagram of 'Wu Chang Rice' processed by MATLAB software

The results of the run are as follows: the total area of 'Wu Chang Rice' rice grains is 16453； there are a total of 12 rice grains of 'Wu Chang Rice'; the average area of 'Wu Chang Rice' rice grains was 1371.08.

The results of the four varieties treated with the above operations are shown in Table 1.

Table 1. Results of each variety of rice processed by MATLAB

serial number	assortment	total area	Number of pieces/pc	Number accuracy/%	Total weight/g	Average area	Hundred grains weight/g
1	Wuchang rice	16453	12	100	10.05	1371.08	8.56
2	long-grained rice	28653	20	100	12.25	1432.65	10.64

3	round-grained sticky rice	43693	25	100	14.36	1747.72	12.25
4	Founder's Rice	56798	30	100	16.32	1893.26	14.38

In the traditional process of seed test, hundred grain weight is an important index to judge the size of rice grain, by analyzing the data in Table 1 can be obtained in Figure 4, the linear regression equation between the average area and hundred grain weight (1). The correlation coefficient 0.009>0, that is, the average area of soybean grain is positively correlated with the weight of 100 grains. r^2 = 0.91965, close to 1. This indicates that the linear correlation between the average area of the rice grain and the weight of 100 grains is relatively high, from this point of view, the use of the average area to determine the size of the rice grain is feasible.

$$y = 496.25841 + 97.30911x,\ R^2 = 0.91965 \quad (1)$$

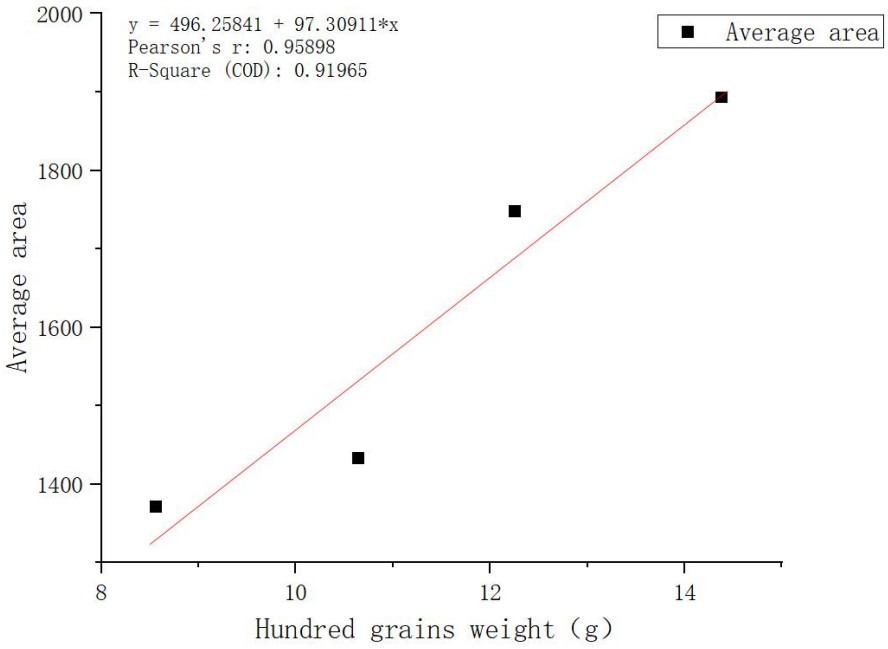


Fig. 4 . Correlation analysis of data of treatment results for each variety of rice

3 Discussion

The experimental data show that the original image of rice grain is in RGB format, by using the function rgb2gray for grayscale processing, the color information of the image will be discarded, and only retain the brightness information, grayscale processing of the image can simplify the image, save storage space, improve the efficiency of the algorithm, and highlight the image outline, which helps to better analyze and process the image [15]. Noise elements in the image can be effectively removed by using the " Otsu " method of morphological median filtering and binarization [16]. Each pixel in a binary image pixel has only 0 and 1, which indicate off and on operations, respectively. Since there are stray points in the binary image for interference, morphological corrosion is usually utilized to make the binary image clear for easy counting.

In the process of automatic detection of grain number and grading of rice single plant test seeds, the number of rice grains is about 100 grains or less, so it can usually be taken to manually place, fix the holes, and shake the grains so that they do not overlap with each other, which makes the grain image feature extraction more convenient [17]. The results of this experiment show that the accuracy of detecting rice particle counting can reach 100% in the case of no overlap of rice particles [18]. The average area of paddy grains calculated by processing paddy grain images through MTALAB software is positively correlated with the 100-grain weight of paddy grains, and the coefficient of determination is 0.91965, which indicates that the average area of paddy grains calculated through paddy grain images can be effective in determining the size of paddy grains [19]. The process of combining computer vision technology with rice seeding may encounter a series of problems such as image acquisition difficulties, rough image processing counts, rough feature extraction, and incorrect grain recognition still need to be further explored and solved [20].

4 Conclude

In terms of research methodology, this study will firstly acquire images of rice grains and perform preprocessing operations including graying, filtering, binarization and other steps to reduce image noise and interference and improve image quality. Then, morphological processing, edge detection and other techniques will be used to extract the feature information of rice grains, such as shape, size and color. Finally, the extracted feature information is classified and recognized by the classification algorithm to realize the automatic detection and classification of rice grains.

Using MATLAB software to process the rice grain images can obtain the rice grain counting results and size with 100% accuracy. This research avoids the defects of time-consuming soybean grain counting instrument and the complexity of the procedure of judging the size of rice grains by using the 100-grain weight index in the process of seeding, which can effectively improve the efficiency and accuracy of work.MATLAB rice grain research is of great significance to agriculture, which can help the farmers, agricultural experts and the relevant departments to better understand the growth status of the crops, optimize the management of production and improve the efficiency of agricultural production and quality of agricultural products quality [21].

References

[1] Cao Lei, Ji Guofa, Peng Chao, et al. Proppant particle roundness and sphericity detection method based on OpenCV image processing [J]. Chinese Science and Technology Paper, 2024, 19 (01): 85-91.

[2] Qiong Li, Yao Yao, Youth Yang, et al. Research on soybean particle detection method based on MATLAB image processing [J]. Chinese Agronomy Bulletin, 2018, 34 (30): 20-25.

[3] Nannan Zhang, Wei Liu, Wei Wang, et al. Research on the detection method of corn grain mold degree based on image processing [J]. China Journal of Cereals and Oils, 2015, 30 (10): 112-116.

[4] ZHOU Zhaoqi, DING Mingyue, ZHU Qingqing, et al. Quantitative analysis of MATLAB images f or electrolytic polishing of 316L stainless steel [J]. Electroplating and Finishing, 2024, 46 (01): 97-10 4.

[5] WANG Li,WANG Wei. Research on face image segmentation algorithm based on MATLAB [J]. Modern Computer, 2024, 30 (01): 70-74.

[6] Zheng Lei. Digital image processing based on MATLAB software [J]. Information Recording Mate rials, 2024, 25 (01): 59-62. DOI:10.16009/j.cnki.cn13-1295/tq.2024.01.024.

[7] QI Zhengdong,YAN Yan,YANG Zhengying,et al. Design and realization of image processing and m achine vision assisted teaching platform based on MATLAB GUI [J]. Journal of Nanjing Xiaozhuang College, 2023, 39 (06): 57-65+81.

[8] DU Yunlong, XU Dongdong, TAO Hongjiang. Research on image edge detection algorithm based on MATLAB [J]. Automation Applications, 2023, 64 (20): 181-183.

[9] Gao X, Wang T, Liu Shuai, et al. MATLAB-based CT image analysis system for wood [J]. Manu facturing Automation, 2023, 45 (09): 40-43.

[10] Li Kunlai, Wang Yunlong, Qin Qin, et al. Comparative analysis of multiple image denoising algorithms in MATLAB [J]. Information Technology and Informatization, 2023, (08): 62-67.

[11] Zeng Huixia, Wu Xunzhong. Implementation of digital image processing system based on MATL AB [J]. Microcomputer Applications, 2023, 39 (08): 79-82.

[12] Wang Yanli. Research on infrared image interface design and image segmentation based on MAT LAB [J]. China Equipment Engineering, 2023, (14): 14-16.

[13] Jin Fei. Research on image restoration technology based on MATLAB [J]. Heilongjiang Science,2023, 14 (06): 139-141.

[14] Chen D Cang. Simulation and realization of digital screening of printing image based on Matlab [J]. Printing Industry, 2023, (01): 79-82+87.

[15] HONG Liang,LIU Jie,WANG Xinru. Image sharpening in Photoshop and Matlab [J]. Guangdong Printing, 2023, (01): 15-16.

[16] REN Meichen,LIU Zhongyi,SUN Shangqian,et al. Digital image enhancement processing based on MATLAB software [J]. Industrial Control Computer, 2023, 36 (01): 105-106+108.

[17] ZHANG Yan,LIU Zhe,ZHOU Ying. Measurement of aesthetic information based on image color a nd texture [J]. Journal of Shenyang Normal University (Natural Science Edition), 2022, 40 (06): 548-553.

[18] JIA Yu, LI Qi, YANG Xiaoqin, et al. Research on edge detection of digital image based on Matlab [J]. Modern Transmission, 2022, (03): 54-56.

[19] CHEN Xiuyan,ZHANG Nan,GAO Peng. Scattering image processing method based on MATLAB [J]. Journal of Shenyang Normal University (Natural Science Edition), 2022, 40 (03): 277-281.
[20] Xuan Zhang, Minna Yi, Fei Song. Three-dimensional reconstruction of lung CT images based on MATLAB [J]. China High-Tech, 2022, (11): 95-96.
[21] Wei L, Hua KM. Research on edge detection algorithm of digital image based on Matlab/GUI [J]. Wireless Interconnection Technology, 2022, 19 (09): 140-142.