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Computer-Aided Inspection (CAI) of Rice Grain Quality Based on Morphological Characteristics

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Abstract:

Computer-aided inspection (CAI) is the use of computer-based software tools that assist quality engineers, machinists, and inspectors in manufacturing product components. The quality of rice is determined by physical (visual) and chemical character (laboratory test). Of the two characters, to test the quality of rice using laboratory tests is very time consuming, as for one relatively fast way of determining the quality of rice is the aspect of the shape and appearance of rice which consists of length (size) and grain shape physically. The image analysis algorithms are applied to an image in which rice grains are randomly placed and spread in one layer.In this study, image processing algorithms were developed to identify rice grains based on morphological characteristics, namely the size and shape of rice grains. After getting the values for length and breadth, the length-breadth ratio is to be calculated. From the analysis that has been done, it can be concluded that the resulting model has an accuracy rate of about 93.3%, so it has a good level of accuracy.

Keywords **— rice grain, Computer-aided inspection, cad, morphological**

I. INTRODUCTION

Rice is a staple food for most Indonesians, which can be said to be a very important food commodity. According to the Ministry of Agriculture, if it is associated with the number of Indonesian population in 2017 which is 262 million people, then the average consumption per capita / per year is 114.6 kg / per capita / per year, this proves that the level of consumption of rice is high by population, maybe along with population growth in Indonesia, the need for rice will also increase[1]. In Southeast Asia, rice is a staple food of 80% of the region's population[2].

Rice is also an important part of fulfilling calorie and nutritional intake for humanity, which provides more than one-fifth of the calories consumed by humans around the world[3]. For this reason, the need for regular quality food products for rice is increasing day by day[4]. Rice quality assessment [5] is still done manually and subjectively through human visual examination[6], [7]even though the quality is very important[8] to increase agricultural income[9].

The quality of rice [7], [10]is determined by physical (visual) and chemical character (laboratory test). Of the two characters, to test the quality of rice using laboratory tests is very time consuming[11], as for one relatively fast way of determining the quality of rice is the aspect of the shape and appearance of rice which consists of length (size) and grain shape physically[12].Rice quality affects the price of rice[13].

Along with the development of technology to determine the quality of rice in terms of the shape and size of rice can be done using tools that are developed through digital image processing so that the bias is faster and easier. Image processing in determining the quality of rice is widely applied, ranging from the acquisition process to the classification process can be determined through the image processing process.

This study will classify the quality of rice based on morphological characteristicsthe size and shape of rice, which in general, the length of rice consists

of length (long grain), medium (medium grain), and short (short grain), the form of rice consists of round (bold), medium , and slender, so that later on the characteristics of the rice grain will be feature extraction, which will be used in analyzing the quality of rice.

Based on the background and identification of the existing problems, the formulation of the problem in this study is how to do Rice Quality Analysis Based on the Size and Shape of Rice to avoid subjectivity in determining the quality of rice because of the limitations of the human eye.

The goal to be achieved in this study is to use a digital image processing approach for Rice Quality Analysis based on morphological characteristicsthe Size and Shape of Rice is expected to be able to reduce subjectivity in determining the quality of rice.

II. Related Works

This research did not escape from previous research which became the basis of knowledge the authors found research problems and became study material for the authors in conducting research, here are some related research:

1. Research conducted by Miss Shivpriya Desai[1] who proposed a simple method using digital image processing and ANN, had an accuracy rate of around 98% of the method they proposed
2. Research conducted by Teresa Philip Mary[14] uses a new approach to feature extraction using a Fast Fourier Transform (FFT) which has a significant effect in analyzing rice quality.
3. Research conducted by Arissa Aprilia Nurcahyani[7] in her research using the Decision tree with the ID3 model has an accuracy of 96.67%.

III. Method

This research was conducted based on the important stages that were done with an orientation towards indicators of success in applying the concept of digital image processing in carrying out a quality analysis of rice based on morphological characteristicsthe size and shape of rice.

As for the steps in analyzing the quality of rice based on morphological characteristicsthe size and shape of rice simply by using a digital image processing approach are as follows:

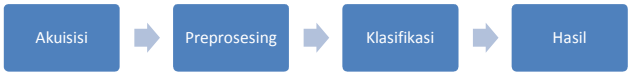

Figure 1 Research Stage

IV. Results and Discussion

The image processing technique is used for counting the number of rice seeds and classifies them on the basis of length, breadth and length-breadth ratio. Length is the average length of rice grain while breadth is the average breadth of rice grain and the length-breadth ratio is calculated as;

$$\frac{L}{B} = \frac{Avg.length\ of\ rice}{Avg.breadth\ of\ rice} * 100 \qquad (4.1)$$

A. *ImageAcquisition*

Image Acquisition is the process of capturing or scanning an analog image so that digital images can be obtained. The image is captured using a digital camera.

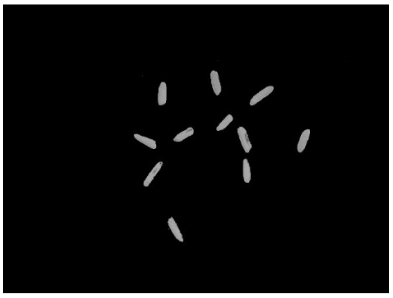

Figure2OriginalImage

B. *Preprocessing*

We capture an image using color camera which is saved in the three dimensional RGB (red, green, blue) color space. The captured image acquired in the desktop using the USB cable which is shown in figure 2. The filter is applied to remove noise which occurs during the acquisition of the image. The filter also sharpens the image. Threshold algorithm is used to segment the rice grains from the black background. Using color extractor color image get converted into a gray image which is shown in figure 3

1. Grayscaling Image
   Grayscale images are distinct from one-bit bi-tonal black-and-white images which, in the context of computer imaging, are images with only two colors: black and white (also called bilevel or binary images). Grayscale images have many shades of gray in between.

Figure 3 (a) Original Image, (b) Grayscale Image

Grayscale images (fig. 3 (b)) can be the result of measuring the intensity of light at each pixel according to a particular weighted combination of frequencies (or wavelengths), and in such cases, they are monochromatic proper when only a single frequency (in practice, a narrow band of frequencies) is captured.

2. Morphological Operation
   Rice grains are randomly spread on a black background. It can be seen in figure 3 that grains are not pointing in the specific direction. In case of touching grains, we can classify them using morphological operation.Image morphology is a process that aims to change the shape of an object in the original image. This process can be done on grayscale images or binary images

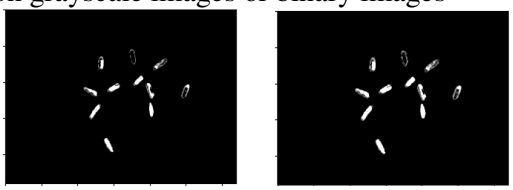

Figure 4(a) Eroded Image, (b) Dilated Image

Touching grains are divided into two types as point touching and line touching. The morphological operation consists of the combination of dilation and erosion. Erosion (fig. 4 (a)) is applied to separate the touching features of rice grains without losing the integrity of the single feature. Dilation (fig. 4 (b)) process follows the erosion process. The goal of dilation is to grow the eroded features to their original shape without rejoining the separated features.

3. Edge Detection
   Edge detection helps to find out the region of boundaries of rice grains as shown in figure 5. We used canny method for edge detection in the proposed methodology.

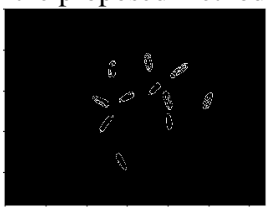

Figure 5 Canny Edge Detection

C. FeatureExtraction

Feature extraction is done to extract the image of rice based on the results of morphological operations, later these results will determine the length of the rice consists of length (long grain), medium (medium grain), and short (short grain). The form of rice consists of bold, medium, and slender.

Feature extraction was performed to obtain features of the shape and length of each rice grain that was detected so that later the feature could represent the shape and size of the rice grains analyzed.

D. ObjectClassification

Classification requires all standard, measured and calculated results. The standard database for rice size and shape measurement is referred from Balitbangtan – Kementerian Pertanian.

As for the classification of the size and shape of rice according to the following table:

Table 1Klasifikasi ukuran Panjang dan bentukberas

Ukuran	Panjang (mm)	Bentuk	RasioPanjang/Lebarbutir
Sangat panjang	>> 7.5	Rampin g	>> 3.0
Panjang	6.61 – 7.5	Mediu m	2.1 – 3.0
Sedang	5.51 - 6.6	Bulat	< 2.0
Pendek	< 5.5		

Sumber: Balitbangtan - Kementrian Pertanian, 2016

E. Computer-aided inspection (CAI)

Computer-aided inspection (CAI) is the use of computer-based software tools that assist quality engineers, machinists, and inspectors in manufacturing product components. Its primary purpose is to create a faster production process and components with more precise dimensions and material consistency.

The results which occurred by implementing image processing algorithms forthe image in figure 1 are shown in table 2, the result indicates the shape and size of rice grains.

Table 2Result of Rice Grain Quality Analysis

No	Number of grain	Grain Length	Grain Shape
1	Grain 1	1.43	Bold
2	Grain 2	1.27	Bold
3	Grain 3	2.86	Medium
4	Grain 4	1.44	Bold
5	Grain 5	1.74	Bold
6	Grain 6	1.76	Bold
7	Grain 7	1.35	Bold
8	Grain 8	1.0	Round
9	Grain 9	1.21	Bold
10	Grain 10	2.44	Medium
11	Grain 11	2.26	Medium
	Average Aspect Ratio	**1.7**	**Bold**

The image analysis algorithms are applied to an image in which rice grains are randomly placed and spread in one layer. If the error occurs like touching kernels shrinkage operation works efficiently for separating the connecting part from point touching kernels. Edge detection is performed to find out the region of boundaries and endpoints of each grain, and then after that using caliper length and breadth can be measured. After getting the values for length and breadth, the length-breadth ratio is to be calculated. From the analysis that has been done, it can be concluded that Average Aspect Ratio = 1.7 (Bold).

F. Evaluation

Evaluation is carried out by simulating the software model developed so that it can be seen that the accuracy of the device model is developed in accordance with the planning and development goals. Evaluations performed by simulation of the image 30 grains of rice to determine the level of accuracy of the model was developed.

As for the results of the accuracy of the 30 (thirty) test images are as follows:

Table 3 Evaluation Results

No	File Name	Execution Time	Avg. Grain Length	Classification Result
1	Beras01.jpg	2.56s	1.70	Bold
2	Beras02.jpg	4.23s	1.26	Bold
3	Beras03.jpg	3.23s	1.43	Bold
4	Beras04.jpg	5.72s	1.52	Bold
5	Beras05.jpg	4.12s	1.63	Bold
6	Beras06.jpg	6.54s	1.86	Bold
7	Beras07.jpg	3.45s	1.32	Bold
8	Beras08.jpg	5.27s	1.16	Bold
9	Beras09.jpg	4.32s	1.95	Bold
10	Beras10.jpg	2.03s	1.62	Bold
11	Beras11.jpg	5.34s	2.12	Medium
12	Beras12.jpg	2.05s	2.18	Medium
13	Beras13.jpg	1.98s	2.76	Medium
14	Beras14.jpg	4.02s	2.43	Medium
15	Beras15.jpg	3.21s	2.21	Medium
16	Beras16.jpg	3.76s	2.58	Medium
17	Beras17.jpg	2.64s	2.66	Medium
18	Beras18.jpg	6.36s	3.00	Slender (X)
19	Beras19.jpg	3.04s	2.13	Medium
20	Beras20.jpg	3.09s	2.11	Medium
21	Beras21.jpg	4.34s	2.99	Slender (X)
22	Beras22.jpg	5.57s	3.13	Slender
23	Beras23.jpg	7.57s	3.09	Slender
24	Beras24.jpg	6.23s	3.16	Slender
25	Beras25.jpg	2.38s	3.10	Slender
26	Beras26.jpg	5.67s	3.00	Slender
27	Beras27.jpg	6.02s	3.19	Slender
28	Beras28.jpg	3.51s	3.07	Slender
29	Beras29.jpg	7.21s	3.13	Slender
30	Beras30.jpg	3.85s	3.02	Slender

In Table 5 above, not all the test images can be identified by the system well, there are some images that have improper identification or identification errors occur.

$$Akurasi = \frac{jumlah\ benar}{total\ citra\ uji} x100$$
$$= \frac{28}{30} x100$$
$$= 93.3\%$$

So, based on the test results with the data presented in table 3 it can be concluded that for the accuracy of the system with 30 test images is 93.3%.

V. CONCLUSIONS

In this study, image processing algorithms are developed to identify rice grains based on shape and size. From the obtained results, it can be concluded that the use of the image processing algorithm is an efficient method to analyze grains quality by its size.

Based on the results of the analysis carried out using the developed software model, the level of accuracy in determining the quality of rice based on physical morphology has good accuracy.

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