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RESEARCH ARTICLE

Edge Detection Techniques for Rice Grain Quality Analysis using Image Processing Techniques

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Abstract

In agricultural countries like the Philippines, rice grain is considered the most important crop in the world for human consumption as daily food and in the food market, thus quality control must be considered. Rice grain quality evaluation is done manually, which is non-reliable, time-consuming and costly. The quality of rice grain is categorized by the combination of physical and chemical characteristics. Grain appearance, color, size and shape, chalkiness, whiteness, degree of milling, bulk density, foreign matter content, and moisture content are some physical characteristics, while amylose content of the endosperm, gelatinization temperature of the endosperm starch, and Na content are chemical characteristics. This paper presents a solution for the grading and evaluation of rice grains on the basis of grain size and shape using Scilab Image Video Progressing (SIVP) techniques. Specifically, an edge detection algorithm is used to find out the region of the boundaries of each grain. This method requires a minimum of time and is more affordable. Edge detection is vital for its reliability and security, as well as for providing a better understanding of automatic identification in computer vision applications. This study determines the best techniques among the edge detection algorithms.

KEYWORDS:
grain quality, image processing, SIVP, grain classification, edge detection techniques

1 | INTRODUCTION

The Philippines is an agricultural country. It has roughly 30 million hectares of land, of which 9.7 million are considered agricultural. The most important crop, not only in the Philippines but all over the globe, is rice. Rice is the most consumed and most favourite food in the world. Determining the quality of rice grain is not always easy as it depends on its physical and chemical characteristics. Physical characteristics such as appearance, color, size and shape, chalkiness, whiteness, degree of milling, bulk density, foreign matter content, and moisture content are hard to define, consume time, and are costly. Moisture content is nothing but the water content in the grain. For better storage purposes, moisture content should be in between 12-14%. Different methods are used for moisture analysis, like the standard moisture meter and the hot air oven method. The chalkiness of endosperm is the white spot present in the rice grain. Chalky areas in rice grains are the grain's opaque white areas. Chalky grain is defined as half of the grain being white in color and brittle in nature. Because of its brittle nature, chalky grains break during milling, so it effects the milling degree of rice. Chalky grains have whole or broken kernels, one half or more of which is white, like the color of white chalk, and is brittle. Chalky grains are conventionally classified based on the nature of the chalky appearance into the following categories: milky-white rice, white-core rice, white-belly rice, white-based rice, and white-back

rice. Chalky rice reduces the deliciousness of cooking, so the presence of chalkiness more than 20% evades the world market. For chalkiness detection, a stereo microscope, magnifying glass, and photographic enlarger are used. The paper focused on grain size and shape analysis using image processing techniques. For the measurement of grain size and shape, the dial micrometer, graphical method, and grain shape tester are used. But all these methods are time-consuming, and some of them are costly. To overcome these limitations, image processing techniques are an alternative and best solution [1]. This paper represents a low-cost (affordable) solution to the problems faced by the agricultural industry. Section II discusses the particular problem of rice seed evaluation on the basis of size and shape, chalkiness, whiteness, and foreign matter content [2]. Manual methods used for the measurement of grain size and shape are also discussed in the same section. Section III discusses the methodology proposed for calculating parameters like length, breadth, length-breadth ratio, and foreign matter content. Section IV discusses the evaluation of the quality of rice grains based on image processing and analysis. It also includes results based on quality analysis for length and length-breadth ratio. Section V provides the conclusion of the proposed edge detection techniques in the classification of rice grain quality. In agricultural and farming production, quality control and analysis of manufactured goods is vital. The quality of grains is analysed visually by a veteran person or a technician [3]. But the effect of such a measurement is that the result is changed and therefore unreliable and time-consuming. The excellence and quality are also influenced by the mood and atmosphere of the technician; so, to overcome the shortcomings that occurred due to conventional methods, a new and advanced technique, i.e., image processing using SIVP, is proposed. Edge detection is important for its dependability and security, which leads to a better understanding of object recognition in computer vision applications.[4]

Edge detection is an important image processing technique that has a wide variety of uses. In the last few decades, several edge detection methods have been developed. Nevertheless, no one technique is suited for all sorts of applications. The process of picture segmentation and object recognition is one of the most common uses of edge detection algorithms.[5].

Rice quality is determined by its physical and chemical characteristics. Grain appearance, color, size and shape, chalkiness, whiteness, degree of milling, bulk density, foreign matter content, and moisture content are some physical characteristics, while amylose content of the endosperm, gelatinization temperature of the endosperm starch, and Na content are chemical characteristics.Percentage of Chalky: Percentage of chalky is calculated using following formula.[6] $\%Chalky = \frac{Actualareaofgrain-areachalkyportion}{Actualareaofgrain} x100.$

Rice grain classifications are classified according to the size of the whole kernel, such as very long, long, medium, and short. Very long rice is categorized as rice with 80% or more of whole milled rice grains having a length of 7.5 mm or above. Longer categories have grains having a length of 6.4mm to 7.44mm, medium has rice grains having a length of 5.5mm to 6.3mm, and short categories have rice kernels having a length of less than 5.5mm. (PNS)

IRRI established the milled rice standard in the Philippines. rice; premium rice, grades 1, 2, and 3, respectively. Premium rice has a minimum head rice quality of 9%, a maximum broken grains quality of 4.90%, and a maximum brewers quality of 0.10%. Grade 1 has 80% head rice, 1.75% broken, and 0.25% brewers. Grade 2 has a head rice content of 65%, a broken content of 34.55, and a brewers content of 0.50%. Lastly, Grade 3 has 50% head rice, 49.5 broken, and 1% brewers.[7].

This paper focused on quality analysis on the basis of the measurement of physical characteristics, i.e., grain size and shape, using image processing techniques. NSIC Rc 160, 218, 216, and 298 milled rice. These rice grain varieties are classified as long, medium, and short [8]. The image processing technique is used for counting the number of rice seeds and classifying them on the basis of length, breadth, and length-to-breadth ratio. Length is the average length of rice grain while breadth is the average breadth of rice grain and length-breadth ratio is calculated as; $L/B = \frac{Averagelengthofrice}{Averagebreadthofrice} x100.$

2 | MATERIALS AND METHODOLOGY

2.1 | Work Flow

Figure 1 shows the work flow block diagram utilized in the conduct of the study.

A camera was used to capture the image of the grain. The image should be 300×368 pixels in size. Then, the image will be processed. In this stage, the result of the original image is converted to grayscale.

Edge detection uses different edge detection algorithms and techniques. These are the canny, Sobel, Prewitt, and fftderiv edge detection algorithms. The object measurement of rice grains will be based on the size of the entire kernel, which might be very long, long, medium or short. Lastly, the classification result was based non the different SIVP techniques.

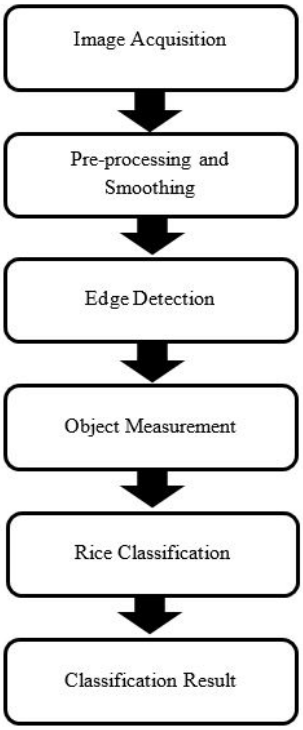

FIGURE 1 Work Flow Block diagram

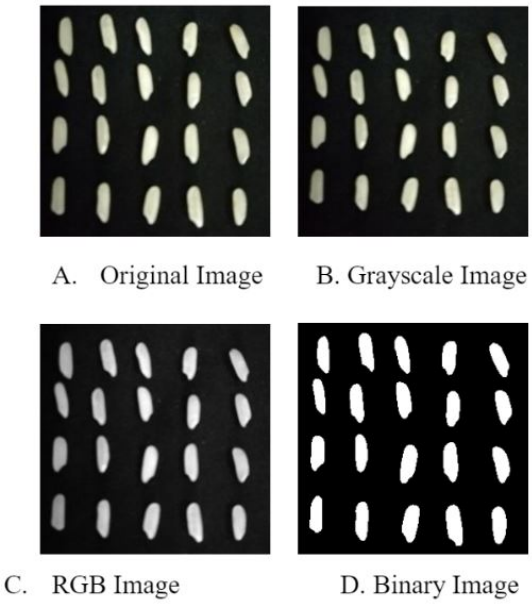

FIGURE 2 Images

Image A. represented the original image acquired using a camera. Image B was a processed image, the result of the original image being converted to grayscale. Image C shows the resulting image of the RGB, and Image D represents the binary image of the rice grain.

2.2 | Edge Detection Algorithms

SIVP has different edge detection algorithms and techniques for determining the edges of the grain needed in the study. These are canny, sobel, prewitt, and fftderiv edge detection algorithms.

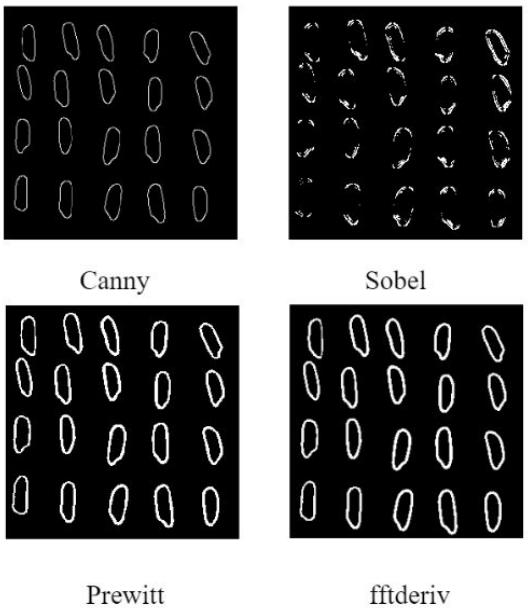

FIGURE 3 Edge Detection Algorithm

2.2.1 | Canny Edge Detection

The Canny Edge Detector is one of the most widely used image processing tools, identifying edges with a good degree of accuracy. The Canny edge detector is widely regarded as the industry's standard edge detection technology. Because Canny perceived the edge detection problem as a signal processing optimization problem, he created an objective function to optimize. Although the answer to this problem was a challenging exponential function, Canny was able to estimate and optimize the edge-searching problem in a variety of ways.

2.2.2 | Sobel Edge Detection

Sobel method is applied to perform edge detection. The algorithm calculates the gradient of picture intensity at each position and then indicates how to raise the image intensity from light to dark at each place. The darker or brighter patches at the edges reflect great intensity differences. Sobel algorithms examine derivatives or second derivatives of digital numbers across space using a mathematical process called convolution.

2.2.3 | Prewitt Edge Detection

Prewitt operator is used for edge detection in an image. It distinguishes between horizontal and vertical edges. The difference between the comparable pixel brightness of an image is used to compute edges. Derivative masks refer to all of the masks utilized for edge detection. Since a picture is also a signal, changes in a call can only be computed via differentiation. As a result, these operators are sometimes known as derivative masks or derivative operators. The following qualities should be included in all derivative masks: (1) opposite sign in the mask, (2) sum of mask equal to zero, and (3) more considerable weight indicates more edge detection.

2.2.4 | Fftderiv Edge Detection

Fftderiv is a SIVP technique that detects edges using the Fast Fourier Transform (FFT) gradient method., 1D and 2D Fourier-based approaches to numeric curvature estimation and their comparative performance assessment.

2.3 | Software Used

This study utilized Scilab. It is a free and open-source software for engineers and scientists, with a long history (first release in 1994) and a growing community (100 or downloads every month worldwide [8].

3 | RESULT AND DISCUSSION

The study used eight rice varieties available on the market. The chalky area and different dimensions of the rice grain samples were calculated, and their respective results are shown in Tables I and II.[9].

TABLE 1 Rice Grading based on length-breadth and size of the grain.

Rice Grain variety	length-breadth	Size	Rice Grading according to size
NSIC Rc 298	68.92%	5.1mm	Short
NSIC Rc 160	70.27%	5.2mm	Short
NSIC Rc 218	78.38%	5.8mm	Medium
NSIC Rc 216	95.95%	7.1mm	Long
NSIC Rc 120	91.89%	6.8mm	Long
SL 8	97.88%	8.0mm	Long
Vietnam	96.47%	7.2mm	Long
Thailand	97.25%	6.9mm	Long

TABLE 2 Rice Grading based on size and chalkiness of endosperm.

Rice Grain variety	Rice Size Classification	Chalkiness	Rice Grading
NSIC Rc 160	Short	5%	Premium
NSIC Rc 216	Long	4%	Premium
SL 8	Long	5%	Premium
Vietnam	Long	5%	Premium
Thailand	Long	4%	Premium
NSIC Rc 120	Long	13%	Grade 1
NSIC Rc 298	Short	32%	Grade 2
NSIC Rc 218	Medium	15%	Grade 2

Rice grain samples are compared based on the endosperm's length, breadth, size, and chalkiness. The giant grain categorized as "long" ranges from 7.5mm and up, "medium" ranges from 5.51 mm to 7.49 mm, and "short" is 5.5mm and below, which are shown in Table 1. Rice classification based on size and percentage of chalkiness, shown in Table 2, was classified as Premium, Grade 1, and Grade 3 rice grain quality.

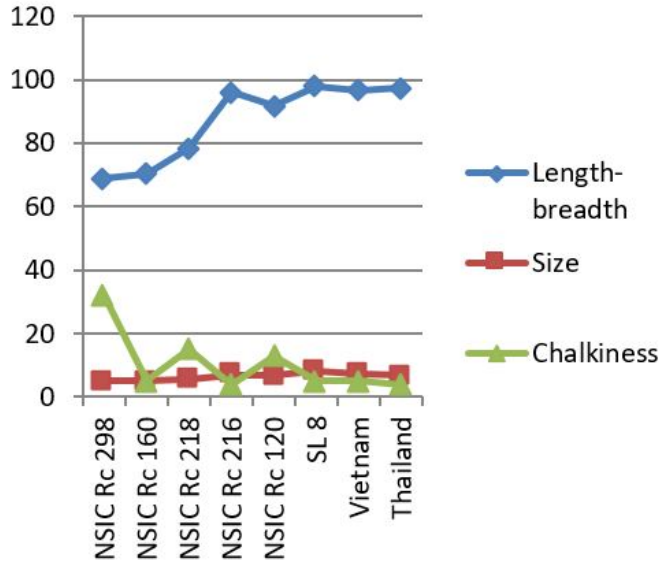

FIGURE 4 Length-breadth, size and chalkiness of different rice grain variety.

4 | CONCLUSION

In this paper, different edge detection algorithms using Scilab Image and Video Processing were applied in the classification of rice grain quality analysis. It shows the length and breadth of the rice grain is directly proportional to its size and can be categorized as short, medium, or long grain. It can also determine the rice grading of the different rice grain varieties. The relative performance of several edge detection approaches is tested with a series of photos in this research article. When compared to other edge detection algorithms, it has been discovered that the Canny edge detection method delivers superior accuracy in edge detection and execution time.

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