Automated Detection of Broken and Chalky Rice Grains using Image Processing

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Abstract—Rice grain quality classification, a growing concern as the Philippines is increasing efforts to produce competitive rice varieties, is a promising area for the application of automated techniques. In this study, computer vision was used to automatically identify broken and chalky rice grains. To establish ground truth for chalky and broken grains, a known small number of broken and chalky grains was added to 100 good rice grains, and several images of this grains set, shuffled a few times, were collected. The developed image processing technique was able to perfectly identify broken grains. As expected, however, the chalky grains were only perfectly identified when the chalky portion of the grain is facing the camera. Overall, the f-measure for the chalky grains detection was still 76.5%. These results indicate the potential for reliably automating the rice grain quality assessment.

Keywords—rice grain, computer vision, agriculture

I. INTRODUCTION

Rice is an important crop in the Philippines. The Food and Agriculture organization reported that the 106.5 million population of Filipinos consumed 110 kg of rice per year in 2018 [1]. Because of the importance of rice crops, the Philippine Government has established the National Standard for rice [2]. Rice grains will be evaluated and categorized in terms of the degree of milling, frequency of broken grains, chalky grains, and the presence of foreign matter [2].

In the conventional process, a human classifier evaluates two sets of 30g milled rice using his or her naked eyes [3][7]. This is a tedious and time-consuming process. A classifier takes 45-90 minutes to evaluate the sample [7]. Different analysts often give different scores to a sample, and even on the same sample may give a wide range of dispersion per grain [3].

Different technologies have been developed that try to programmatically classify rice grains through computer vision techniques [4][5][6][7][8]. Most studies use a controlled set up with a camera capturing images of rice with a black background in well-lit box. A variety of machine learning techniques are typically used [4][5]. Though some of the technologies have high accuracies, most of the classification and categories used do not fit the Philippine setting.

At least two projects in the Philippines have attempted to address this. The first project, done in Philmech [8], was comparable with its human assessors counterpart, although it differed significantly in some categories. The second project in PhilRice [7] was able to cut down the time to classify rice grains from 45-90 minutes[7] to just less than 5 minutes[8]. The technology, however, has not yet been made available to farmers and traders as is still in the early stages of development. These two systems both used Neural Networks as the base classification technique to identify whether a grain of rice is chalky, broken or regular.

This research aims to improve upon these technologies by increasing the accuracy of the computer-vision based classifiers. The developed technology is then intended to be made accessible to traders, millers, and eventually to the farmers and consumers.

II. METHODOLOGY

A. Gathering Data

The sample images needed for this research are currently not available in any online database. Thus, data was first gathered by collecting appropriate images that can be used for developing the algorithm and then testing its effectiveness. Towards this end, 100 regular grains (non-broken and non-chalky) were first collected and their lengths were carefully measured using a digital caliper. This is to ensure that none of them were broken based on the standard defining broken grains to be having length less than 70% of the average grain length [2] Afterwards, 10 broken grains were added, and all were placed on a red surface. The position of the grains was changed by shuffling them across the surface, and 10 images were obtained. Afterwards, 10 chalky grains were added to the grains, and the process was repeated. All images were captured using a mid-range priced smart phone

B. Using Image Processing to Identify broken and chalky grains

A combination of Ohtsu's binary thresholding and in range thresholding was used to separate the rice grains from the red surface that serves as the background. A smallest bounding rectangle was then used to estimate the length of each individual rice grain. Based on the rectangle lengths, grains with lengths less than 70% of the average length were classified as broken.

The chalky grains were identified by generating a histogram of the pixel values, and then sorting the rice grains by the mode of their whiteness level and finding the point where there was a great change in the slope of the modes.

The program was calibrated to identify properly broken and chalky grains (see Figure 1).

Fig. 1. Initial Test and Calibration for Broken(blue) and Chalky (pink)

C. Evaluation

The image processing method was tested against the actual count of broken and chalky grains on a different set of 10 images each, and the correctness on each test was recorded.

III. RESULTS

The program was able to perfectly identify broken grains on all test cases (see Table I). In the first 9 images, the program was able to identify all 10 broken grains. In the last image it found 12 broken grains because one rice grain was actually split into two due to the shuffling. Overall, the program performance was 100% for precision, recall and f-measure.

TABLE I. BROKEN GRAINS RESULTS

Trials	Number of Grains		
	Good Grains	Actual Broken	Counted Broken
1 to 9	100	10	10
10*	99	12	12

a. A rice grain broke i to two and became two broken grains

Fig. 1. Example of a figure caption. (*figure caption*)

For chalky grains, the program was able to perfectly identify all of the grains whenever a portion of the grain's chalky side was visible (this was established through manual inspection of each given image). Refer to Table II for the detection rate details. Overall, the program had a 62% recall, 100% precision, and 76.5% f-measure.

TABLE I. BROKEN GRAINS RESULTS

Trial	Total Number of Grains	Actual Chalky	Detected Chalky
1	121	10	4
2	121	10	7
3	121	10	6
4	121	10	7
5	121	10	8
6	121	10	5
7	121	10	6
8	121	10	6
9	121	10	7
10*	121	10	6

IV. CONCLUSION

In this study we developed a technique for automatically detecting broken and chalky grains from an image of grains. In the experiments, the broken grains were perfectly detected all the time, while the f-measure on the chalky grains detection was at 76.5. These results indicate the potential for reliably automating the rice grain quality assessment. The method to determine broken grains also enables the use of phones to capture the images instead of a fixed distance image capture device like a scanner.

Currently the system requires individual rice grains to be separate or not touching each other to properly identify the rice grains. Future studies could look into properly segmenting touching grains and adding classification methods for other features like degree of milling, and detecting foreign matter in the sample

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