Quality Assessment of Thai Rice Kernels Using Low Cost Digital Image Processing System

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Abstract—This paper presents a low cost digital image processing system for quality assessment of Thai rice kernels. Nowadays, Thailand is the top country which export rice into the world market, according to the mention of the Rice Trader, the export volume is 9,883,288 tons in 2016 and export value is 154,434 million baht or 4,401 million dollars. Thai rice quality is controlled by rice department, ministry of commerce Thailand in order to guarantee the quality in market including prices base on grade of rice quality. Thence, quality assessment of Thai rice kernels is required. Quality assessment or grading of Thai rice kernels usually use manual operation by person in cooperating with equipment called micrometer to measure geometrical features such as length, width, and area of rice kernels. This method takes a long time and also gives uncertainty in results due to eye fatigue because size of rice kernels is very small. Therefore, an image processing technique is then applied to measure size of Thai rice kernels. Proposed system consists of flatbed scanner and image processing algorithm which correspond to measure of Thai rice kernels. The low cost system for quality assessment of Thai rice kernels can be delivered to Thai rice industry, the certainty of results and speed of quality assessment can be significantly improved.

Keywords— Rice Quality; Size of Rice Kernels; Flatbed Scanner for Seed Count; Image Processing Analysis.

I. INTRODUCTION

Thailand is an agriculture country. There are 22 million agriculturist. 16.1 million of them are the farmers, accounting for 22% of the population in Thailand. There is 58 million rai of rice fields. In 2016, Thailand had exported nearly 10 million tons of rice into the international market trade and it equaled to 154,434 million bath or 4,401 million dollar [12]. Therefore, the quality assessment is an important part of the production process for Thai rice industry to categorize the level or grade of rice quality in order to conduct with the fair and appropriate price.

However, it already exists Thai rice quality assessment manners, but it is still made with non-proper results and high consumption resource. Those ways are:

- The first one is the manual operation conducted by human using equipment called micrometer to measure geometrical features such as length, width, and area of rice kernels. This technique takes a long time and also gives uncertainty in results due to eye fatigue because the size of rice kernels is tiny and
- The second is the quality assessment or grading have to be made by the expertise of rice. Most of the small community mill or small mill can't employ those people because they have less budget.

On the other hand, in the science techniques there are many methods have been used to make a classification of rice kernel, including [1] using Scion and Leica Qwin method to find length, width and other feature use Morphological. The emphasis is on the size of grain and the classification of broken kernels and chalk defects using a flatbed scanner and image processing to determine the size and grain broken by geometrical features. In addition, [2] the machine learning algorithm Neural Network using Back-propagation has been employed to make the classification of broken kernels and chalk defects by operating with the geometrical feature from Matrox imaging library. The results provided with 90% accuracy. Moreover, [3] has used machine vision by Sony digital camera machine with image processing to assess the quality of the grain and Morphological to find the physical properties of the line, Major Axis, Minor Axis, Area, and the ratio between Major Axis and Minor Axis. The physical characteristics of rice were evaluated by using Neural Network PNN Probabilistic Neural Network. Inside [4] presents an assessment of grain quality emphasizing on broken rice, head rice, small broken rice, and large-sized rice discarded in rice production by Least-Square Support Vector Machine (LS-SVM) and Radius Basis Function (RBF) with the accuracy of 98.20%. The another technique of the combination of machine vision and Morphological to find the geometrical feature like [3] but Neural Network Back-propagation is used to classifier the grade of rice kernels, [5] has provided other accuracy of 96%. Furthermore,[6] purposes a classifier of the broken rice kernel which is considered with the length 75% of whole grains by using morphological to extract geometrical feature and then use Artificial Neural Network (ANN) to discriminate rice kernels while in [7] focuses on the separation of broken rice into broken rice grades

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as follows: 0% broken rice, 1% broken rice, 5% broken rice, 10% broken rice, 15% broken rice and 20% broken rice using a scanner and image processing and then find geometrical features by using Morphological and correlation between each other features to discriminate grades. In other research work, they still use technique of morphological to extract geometrical features and assessment then make a classification of the grades of Food Grains but use different machine learning algorithm such as Probabilistic Neural Network (PNN) like in [8]. Other used exterior quality inspection [9] by optical and CCD camera which developed by the platform of VC ++ 6.0 software. The results showed that the accurate ratio of detecting crackle rice was 96.41%, the correct ratio of detecting chalk rice was 94.79%, and the accurate ratio of detecting head rice was 96.20%. In opposite of those work, [10] Thai Standard of Rice has been used to constraint the grade of the rice kernel, Ministry of Commerce Thailand, 2016.

This paper presents a method to assess Thai rice kernels using image processing and flatbed scanner. The flatbed scanner is a low-cost equipment can be easily bought in the market and independent of external light condition. The flatbed scanner Canon LIDE 110 was used for experimental which was set in mode grayscale 8 bits and a resolution of 600 dpi with USB interface to a laptop with 12GB RAM as software as Development with Matlab.

II. METHODOLGY

This paper focuses on the solution to solve the main problems in Thai rice industry including human replacement in the process of quality assessment because it takes so long time and also gives uncertainty in results as well as is the low-cost equipment for Thai rice industry forasmuch the assessment of Thai rice kernels is difficult. It needs the knowledge and training including.

Hence we need to find the best way in order to obtain an actual length of Thai rice kernels for precisely assessing the grade of Thai rice kernels. First, we have to find the length like SCION software assume that the rice kernels are ellipse shape [1] which the length along the major axis and width along the minor axis. The length is obtained nearly the manual analysis by the expertise in case of the kernel ellipses shape Fig. 1 and over the length in case of another shape Fig. 2 The Thailand's rice grain has a variety of shapes. The method assumes the kernels are ellipses shape cannot use in Thai rice industry.

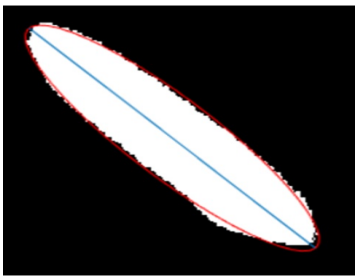

Fig. 1 Assumption ellipse shape in red line and blue line is major axis.

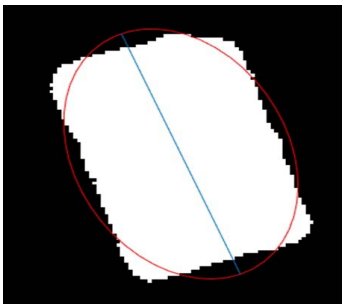

Figure 2: Assumption ellipse shape in red line and blue line is major axis.

Second, we must use the Feret diameter method to find the length which be implemented in the Programming Matlab by using David Legland library. The length value that we obtain nearly the length which, manual analysis by expertise in case of size 5-7 mm. and other sizes over the length compare with manual analysis Fig. 3-4.

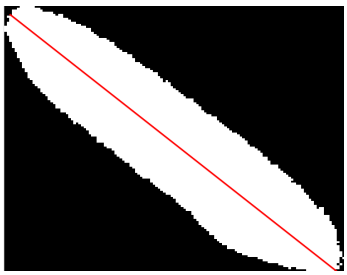

Fig. 3 Drawing Feret diameter in red line in case of size 7 mm which obtain from library

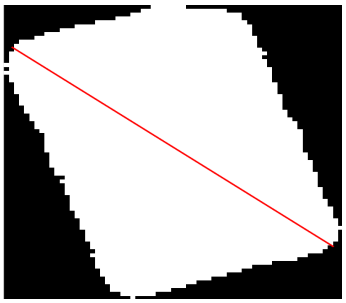

Fig. 4 Drawing Feret diameter in red line in case of size 4 mm which obtain from library

Therefore, this paper presents the method to find the length that the value nearly manual analysis by expertise and operation with the low-cost flatbed scanner. The basic steps in the classification and grading of rice are as follows:

- Input the image from a flatbed scanner in a grayscale image in pixels to millimeters and then transform the image from grayscale to binary image by the histogram and setting the threshold to 100.
- Eliminating noise by using morphological opening and Morphological Label Connected Component [11]
  1. Morphological Opening by equation

$$A \circ B = (A \ominus B) \oplus B \quad (1)$$

Where A is the metric of image, B is square metric 3x3 which all value equal 1

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Using operation Erosion $\ominus$ *and Dilation* $\oplus$

2. Morphological Label Connected Component in order to segment each kernels by equation

$$(A \oplus B) \cap A \quad (2)$$

Where A is the metric of image, B is square metric 3x3 which all value equal 1

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Using operation Dilation $\oplus$ *and intersect* $\cap$

And then eliminate Label Connected Component which have the pixels less than 1250.

- Cropping each labels of kernels. Measuring geometrical features [7] that the center of the axis, including the orientation angles of each kernels.
- Rotation each kernels by equation

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \quad (3)$$

Where θ is the orientation angle. The result drive the rice in upright direction (fig.5-6)

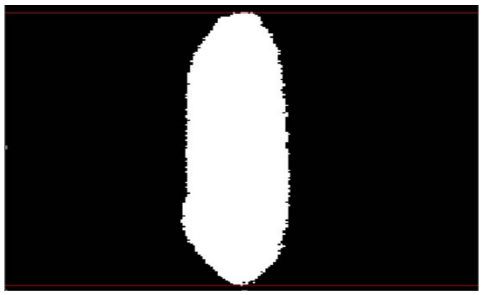

Fig. 5 The result rice kernels in ellipse shape after rotation.

Fig. 6 The result rice kernels in another shape after rotation.

Measuring the length by using Y coordinate of white pixel Ymax-Ymin and width using X coordinate Xmax-Xmin. Bring the result length and width multiply with Pixel per millimeter.

- Preliminary assessment of grade rice kernels into 6 grades consist of Whole grain is more than 7.00 mm., Broken Nose is rice with a length of 6.6-7.0 mm., Rice Head Rice grade is 5.2-6.6 millimeters., Grade Broken Nose No.2 4.22-5.19 mm., Grain Broken Nose No.3 3.25-4.21 mm., Grain Broken Nose No.4 2.27-3.24 mm. and Broken Nose No.5 Grade Less than 2.27 mm.

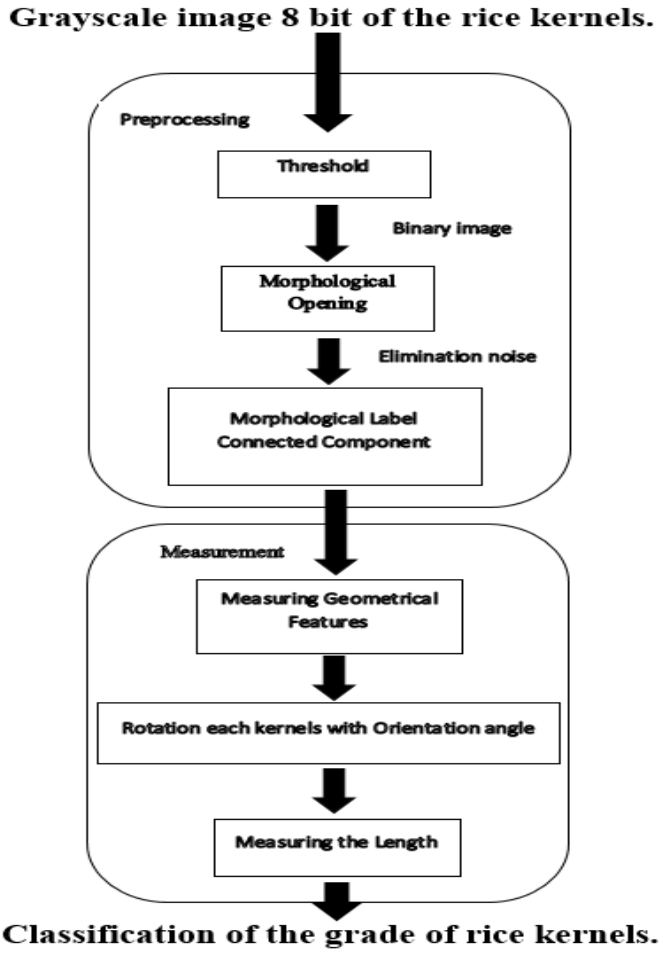

Fig. 7 Block Diagram of the presentation method.

III. RESULTS

Comparison of the length results from three methods as follows: Scion, Feret diameter and the proposed method in this paper compare with manual analysis by the rice expertise by example rice kernels 6 sizes consist of 7.0-7.1, 5.3-5.4, 4.9-5.0, 4.8-4.9, 4.0-4.1, 3.0-3.1 and 2.0-2.1 which each sizes has 100 kernels from universal rice co. ltd. We found the length result of assumption that the rice kernels are ellipse shape contains obtain the result of average length nearly manual analysis by rice expertise in case of only size 7.0-7.1 mm. and in case of other sizes the results of average length over than manual analysis by rice expertise shown in TABLE I. The length result of ferret diameter nearly the manual analysis than

the method assume that the rice kernels are ellipse shape which the average length value is the nearest in case of sizes 7.0-7.1, 5.3-5.4, 4.9-5.0, 4.8-4.9 and 4.0-4.1 and also has standard deviation less than ellipse shape method. The other average results in case of sizes 3.0-3.1 and 2.0-2.1 over than manual analysis shown in TABLE II. The length average result of the proposed method which obtain the nearest manual analysis than ellipse shape method and Feret diameter method and also has standard deviation less than other methods.

TABLE I. The length result compare between manual analysis with ellipse shape method

Manual analysis (mm.)	Ellipse shape mean (mm.)	Ellipse shape max (mm.)	Ellipse shape min (mm.)	Ellipse shape standard deviation (mm.)
7.0-7.1	7.12	7.23	6.86	0.07
5.3-5.4	5.87	5.94	5.70	0.15
4.9-5.0	5.41	5.75	5.33	0.10
4.8-4.9	5.26	5.41	4.88	0.13
4.0-4.1	4.39	4.57	4.23	0.10
3.0-3.1	3.30	3.38	3.20	0.08
2.0-2.1	2.42	2.58	2.32	0.07

TABLE II. The length result compare between manual analysis with ferret diameter method

Manual analysis (mm.)	Ferret diameter mean (mm.)	Ferret diameter max (mm.)	Ferret diameter min (mm.)	Ferret diameter standard deviation (mm.)
7.0-7.1	7.08	7.12	6.98	0.11
5.3-5.4	5.55	5.93	5.38	0.14
4.9-5.0	5.11	5.23	5.02	0.08
4.8-4.9	4.99	5.15	4.89	0.07
4.0-4.1	4.28	4.45	4.12	0.07
3.0-3.1	3.37	3.49	3.25	0.10
2.0-2.1	2.67	2.91	2.45	0.13

TABLE III. The length result compare between manual analysis with proposed method

Manual analysis (mm.)	Mean (mm.)	Max (mm.)	Min (mm.)	Standard deviation (mm.)
7.0-7.1	7.06	7.10	7.01	0.09
5.3-5.4	5.40	5.50	5.24	0.05
4.9-5.0	5.02	5.12	4.95	0.05
4.8-4.9	4.89	4.99	4.82	0.05
4.0-4.1	4.14	4.36	4.02	0.08
3.0-3.1	3.20	3.30	3.00	0.10
2.0-2.1	2.25	2.57	2.20	0.11

Quality assurance in Thai rice industry. The rice sample product 25-gram from rice product of 1-ton to make sure that Rice product have the precise quality with the customer order. Therefore, the manual analysis takes a long time because rice produced 25-gram have the kernels 700-900. The manual analysis uses equipment called micrometer. It can be measured only 1 kernel per 1 time which takes time about 2 hours per rice product 25-gram. The result of time processing which compared to manual analysis with proposed method, ellipse shape method, and the Feret diameter method. We found that proposed method can save time more than manual analysis. It takes time only 1-2 minutes for the process compared to 2 hours.

IV. CONCLUSION

In this paper, the proposed method can find the length of Thai rice kernels efficiently and also use low-cost equipment in order to assess the grade of Thai rice kernels. The results are getting to the nearest manual analysis than ellipse method and Feret diameter method. The time processing of proposed method saves more time about sixtyfold when compare to the manual analysis and also has stability than manual analysis

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