Available online www.jsaer.com

Journal of Scientific and Engineering Research, **2018, 5(3):108-121**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Non-destructive Identification of Breeding Rice Seed by Using Image Processing and Fuzzy Logic

Somthawin Khunkhet, Tawun Remsungnen

Applied Mathematics, Graduate School, Khon Kaen University

Abstract Rice is the most important cash crop in Thailand. The rice yield depends on quality of rice seed identifying which is very important. Normally, the adulteration of plain rice and sticky rice effect on changing of rice quality which does not meet the needs of market. This study proposes the method of unmilled Jasmine rice 105 identifying (non-destruction) by image processing and fuzzy logic. The images of rice seeds are taken and imported by scanner. The sample groups in this study consist of 1,325 Jasmine rice 105 seeds, Kor Khor 6 sticky rice 1,040 seeds. The traits of unmilled Jasmine rice 105 which is more perimeter than sticky rice which results in the difference of area per the diameter ratio. Besides, the colour of unmilled sticky rice having more intensity will have unequal RGB histogram. The tolerance acceptable tests with two of 300 seeds sample, shows the statistical accept of the difference at 0.05 of significance level. The experiment with sample of 732 seeds, show that 667 seeds could be pure seeds and 65 seeds could be other seed. The 667 of pure rice seeds are correctly identified 656 seeds (98.35%) and 65 of other seeds correctly identified 49 seeds (75.38%)are obtained for the proposed method.

Keywords non-destructive, rice seed, image processing, RGB, Fuzzy logic

1. Introduction

Rice is one of the world's important food crops, particularly in Asian region where people there prefer to eat rice as a staple food. Thus, rice production, consumption and trading mostly flock in Asia continent. However, most rice production is for domestic consumption, only 6 percent involves in international trade. India played role in the most rice exporter in 2016 (January– November, 2016) [1] with an amount of 9.62 million tons. This amount of rice export declined to 6% compared to the previous year. It was followed by Thailand with an amount of rice export of 8.71 million tons which increased by about of 1.6%. Vietnam is ranked third with an amount of rice export of 4.6 million tons which decreased by amount of 23.1%. Africa was the biggest rice market (4.7 million tons, 48.3 proportions) and followed by Asia (3.61 million tons, 36.9 proportions), America (5.8%), Europe (3.9%), Middle East (3.4%), and others (1.8%). The rice categories which are exported by Thailand included White rice (4.48 million tons–51.5 proportion, 1% decrease), Jasmine rice (2.03 million tons–23.5 proportion, 17% increase), and steamed rice (1.96 million tons–22.4 proportion, 6.7% decrease), respectively.

Indica rice has tapering seed and tall stem grown in Monson region of Asia i.e. China, Vietnam, Philippines, Thailand, Indonesia, and Sri Lanka. It was firstly found in India and introduced to America continent later. There are about 3,500 varieties of this rice, which include wild rice, local rice, and manmade hybrid rice. Jasmine rice is the most reputation rice of Thailand which has night–time longer than day–time period. In other word, Jasmine rice can only be grown during the cold season (an in–season rice field). It is called "Jasmine rice" because its colour is white like that of jasmine flower but its fragrance is like that of Pandanus leaf. Interestingly, the rice is softer and more fragrant than general rice when it has been steamed. There are two

Jasmine rice varieties in Thailand: 105 Jasmine rice and Kor Khor Jasmine rice. In fact, the latter is also 105 Jasmine rice that irradiated with gamma ray in order to making it has higher yields than 105 Jasmine rice for 4–6 percent [2].

1.1 Background and significance of the study

Nowadays, rice is an important cash crop to Thailand since most Thai farmers mainly grow rice which is needed by both domestic and foreign markets. Jasmine rice 105 is widely grown in northeastern and upper northern Thailand [3]. The Rice Department of Thailand is responsible for keeping of Jasmine rice 105 varieties. The rice seed is classified into 4 classes: breeder seed, foundation seed, registered seed, and certified seed. Each class has an increased amount and different standard as shown in Table 1 [4].

Table 1: Specifications of rice seed standards.

Seed class	%N	%C	%G	%M	No. of other rice seed	No. of red rice seed
Breeder seed	≥ 98	≤ 2	≥ 80	≤ 40	0	0
Foundation seed	≥ 98	≤ 2	≥ 80	≤ 40	≤ 1 seed out of 1,000 g	0 seed out of 500 g
Registered seed	≥ 98	≤ 2	≥ 80	≤ 40	≤ 15 seed out of 1,000 g	5 seed out of 500 g
Certified seed	≥ 98	≤ 2	≥ 80	≤ 40	≤ 20 seed out of 1,000 g	10 seed out of 500 g

N: Net seed, C: Contamination, G: Germination, M: Moisture

1. Breeder seed refers to rice seed obtained from ear of rice seeds which are grown in column. It is determined by the breeder who selects and characteristics in accordance with the designed breeder. That mean this seed is under the control and careful checking of the varieties based on strain and standards.
2. Foundation seed refers to the rice seed grown for an increased amount. The rice seed strain is selected in accordance with propagation, the exact species, and standards of foundation seed quality.
3. Registration seed refers to the rice seed obtained from growing for an increased amount. Breeder seed is used in accordance with the steps of propagation, the exact species and standards of registered seed quality.
4. Certified seed refers to the rice seed obtained from growing for an increased amount in which registered seed is used in accordance with the steps of propagation, the exact species, and standards of certified seed quality.

The Ministry of Commerce has determined rice standards by classifying types of rice quality based on type, quality, and physical components which can be checked by eye-sight. Examples are hull colour, pericarp colour, grain weight, grain dimension, chalkiness, grain transparency, grain hardiness, whiteness of milled rice, and milling quality.

Three categories and physical appearance of economic rice are follows : (Figure 1)

(A) (B) (C)

Figure 1: (A) Jasmine rice 105 (B) Kor Khor rice 15 (C) Kor Khor rice 6.

Table 2: Physical appearance of the three rice strains.

No.	Rice strain	Hull colour	Hull size
1	Kor Khor 6	Brown	9.9 × 2.7 × 2.0
2	Jasmine rice 105	Rice straw colour	10.6 × 2.75 × 1.9
3	Kor Khor 15	Straw colour (little twisted end)	10.7 × 2.5 × 1.9

Since rice is needed much thus rice farmers and concerned business focus on an amount of rice rather than quality. Consequently, there is adulterated rice by the mixture of other rice varieties happening in all levels of market in both unmilled rice and milled rice. Importantly, it is different to inspect in some cases such as in the case of sticky rice mixed with Jasmine rice 105 for an increased profit. Therefore, concerned government agencies have to control the quality and set measures for exporting rice. One of the measures is the inspection of breeder seed to confirm the parity of the rice varieties. In fact, Jasmine rice can be adulterated by man and nature. For example, pollen may be carried by the wind from the neighboring fields of other rice varieties. As a matter of fact, the adulteration of Jasmine rice 105 strain in the same ear of rice is the problem happening in all Rice Residence Center throughout the country (2% tendency)[4]. Examples are shown in Figure 2 in the same traits (Figure 3) as compared with sticky rice and the difference can be observed when unhulled (Figure 4).

Figure 2: A specimen of an ear of rice having the mixture of rice and sticky rice.

(A) (B) (C)

Figure 3: A specimen of rice (A), rice which inside is sticky rice (B) and stickyrice (C).

Besides, farmers use rice seed strain which is used consecutively in many seasons and without correct selection method. This usually has a problem in the mixture of other rice strains, resulting in quality recession. Therefore, careful rice strain selection can maintain quality of rice yields. However, a self–sight selection method is lack of accuracy in quality and is time consuming.

This study proposes the identification of unmilled rice seed by photograph organizing which later can be used in developing a simple to use and high accuracy recognizing unmilled rice tools for cultivation. The farmers, then can use to obtain basis data for decision-making to continue with own collected seeds or with new seeds from the Rice Research Center or the Agricultural Cooperative, or further advanced applications.

(A) (B) (C)

Figure 4: A specimen of husked rice (A), milled rice which inside is sticky rice (B), and milled sticky rice (C).

1.2 Related the studies

Regarding the construction of rice seed identification system, milled rice is mostly used as a basis of the identification. This is because the milled rice is rather close to daily life of man than unmilled rice seed. However, problems in milled rice will be always happened if there is no study on unmilled rice. The method of rice seed identification is usually based on physical appearance since milled rice of each area has different traits. The method of rice seed identification is classified into 2 groups : milled rice and unmilled rice (Figure 5).

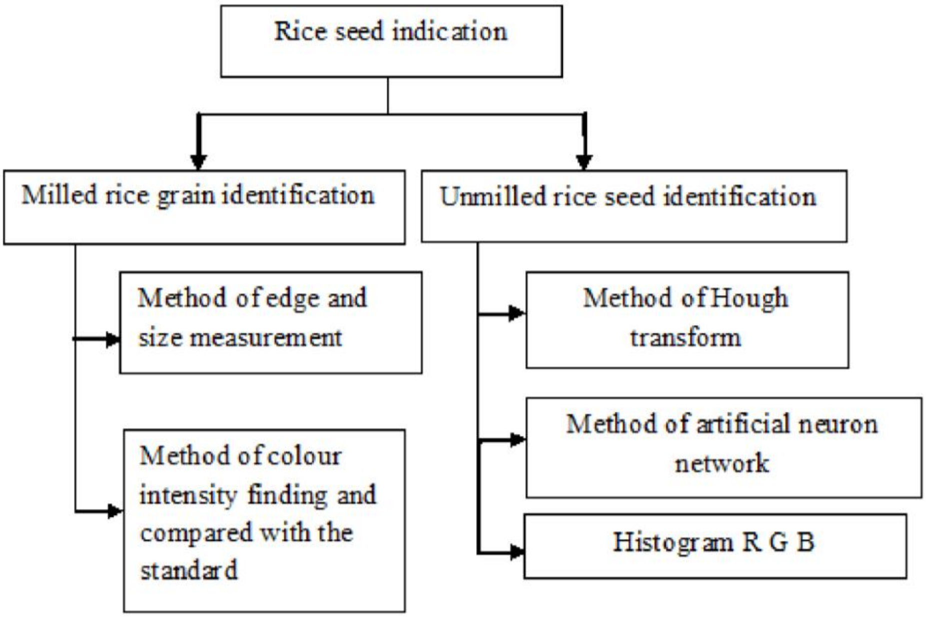


Figure 5: Research cluster on rice seed strain identification

1.2.1 The identification of rice seed strain by using milled rice

The identification of rice seed strain using milled rice placed in a light control box. LED is used for providing light to the milled rice in the same side with the camera installation site. Hobson, Carter, and Yan[3] proposed a method of specific trait identification and identity verification of 8 different varieties milled rice by using CCD camera (grayscale). After that, the 8 rice varieties are analyzed for finding the edge of rice seed for measuring width, length, and the intensity of the grain colour. The mean of clustering technique is applied. The difference among the 8 varieties is shown (Figure 6). The identifications using low resolution and high resolution gave similar results.

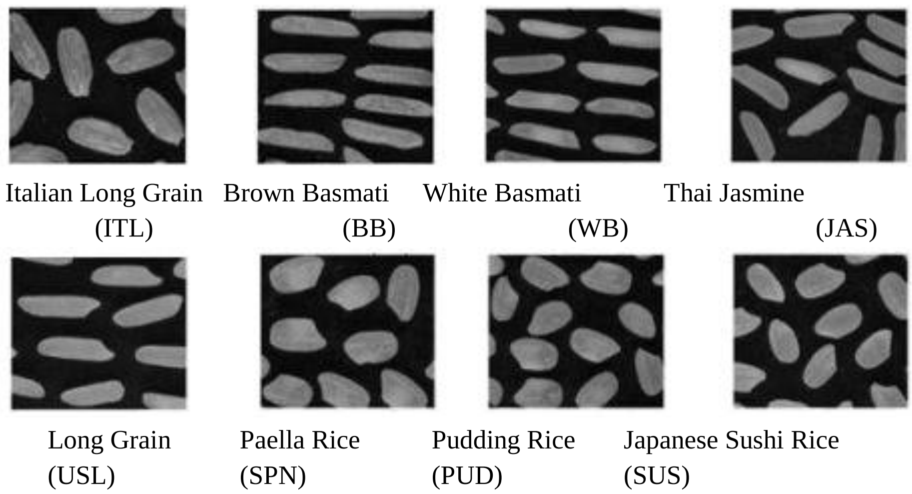
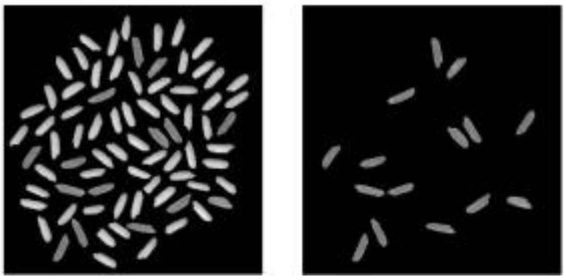


Figure 6: Eight rice seed trains [3]

Nakonrat, Aunsrimuang, and Matthanang[5] proposed a method of rice quality measurement which is related to physical properties of milled rice grain. This can be done by making a record of the milled rice grain using scanner instead of a camera. This aims to reduce difficulty in the image processing procedures having the following components: intensity of light and background colour and the actual size of the milled rice grain, etc. black background. After that, rice and sticky rice seed strains are identified based on colour of the milled rice grain. This is the employment of physical traits which is important to the identification of kinds of milled rice having the difference in colour property. The colour dispersion of rice seed in the form of histogram is employed and an average mean score of each milled rice grain is computed. (Figure 7)



(A) (B)

Figure 7: (A) rice grain mixed with sticky rice grains, (B) sticky rice grains which have been identified [5]

Regarding the detection of the rice having white opaque in colour, Guangrong [6] proposed a method which is similar to that of Nakhonrat et.al. for detection of the rice having the white opal in colour.

1.2.2 Identification of rice seed strain by using unmilled rice seed

The identification of rice seed strain by using unmilled rice seed is a rapid method and easy to be caused. Physical traits of rice grain in each area are unique so there is the identification of unmilled rice seed traits by using image organizing method. Fang and Yi-bin[7] Proposed a method of unmilled rice seed strains detection and the incompleteness of unmilled rice seed. The images of the unmilled rice seeds having white and black background with LED light which is provided from its source (Figure 8).

Ou Yang et.al [8] proposed a method of the identification of appearance and difference of unmilled rice seed. This is by mean of Machine Vision Technology in sorting the 5 strains of rice seed having different physical traits (Figure9). There is image recording, material preventing outside light penetrating inside, and the seed light provided by fluorescent lamp. A CCD camera is used to record images in RGB colour. An artificial nervous network is applied in identifying.

(A) (B) (C)

Figure 8: (A) normal unmilled rice seed (B) unmilled rice seed having a crack (C) unmilled rice having opened husk [7]

(A) (B) (C)

Figure 9: (A) Unmilled rice seed No.5 'Xiannong' (B) Unmilled rice seed 'Jinyougui' and (C) Unmilled rice seed 'You 166' [8]

Punthumast, Auttawaitkul, Chiracharit, and Chamnongthai [9] proposed a method of the identification of the unmilled rice seed of Jasmine rice 105 strain (no destruction form). A image is recorded by a digital camera with single–lens relax. This is together with a source of fluorescent light (white) placed under a sample group of rice seeds. Result of the experiment conducted with a sample group of 600 seeds shows the sensitivity value for 99.78%, the specificity value for 92.45% and correctness value for 99.13% when compared to result of the identification.

Dadwal and Banga [10] developed an approach to estimate the ripeness level without touching the fruit. The two techniques were used in this approach are–color image segmentation and fuzzy logic technique. Yao, Zhou, and Wang [11] proposed a comprehensive AI laboratory using fuzzy logic for colour sensing from applying the fuzzy inference system using MATLAB to implementation on a low–cost educational microcontroller–based system.

The said methods of rice seed indentifying can indicate the milled rice seeds with different strain. However, the adulterated of unmilled rice seed with the same external traits but the difference in the internal traits still not yet indicated. That is, the external traits are like the rice seed but it is the sticky rice seed when it was cracked. This study proposes a visual classification system to identify the varieties of rice seeds by their colour features and its appearance size of the rice seeds. The method entails the development of an algorithm ratio between image segments and varieties of different shades. Seed boundaries are separated by using morphological processing techniques. The colour features are using fuzzy logic technique to identify the rice seeds with the correct identification of RGB colour rate.

2. Research methodology

The identification of unmilled rice seed is very important because it can maintain purity of unmilled rice strain. The traits of Jasmine rice 105 are white like jasmine, softer than other strains when steamed, and its fragrance is like that of pandanus leaf. It is the rice widely needed by Thai people and foreigners. The image analysis for unmilled rice seed identifying without seed destruction (non– destruction form) comprises 2 parts : first is system of hardware and software, second is analysis procedure, which are detailed as follows :

2.1 Structure of the identification of unmilled rice seed system

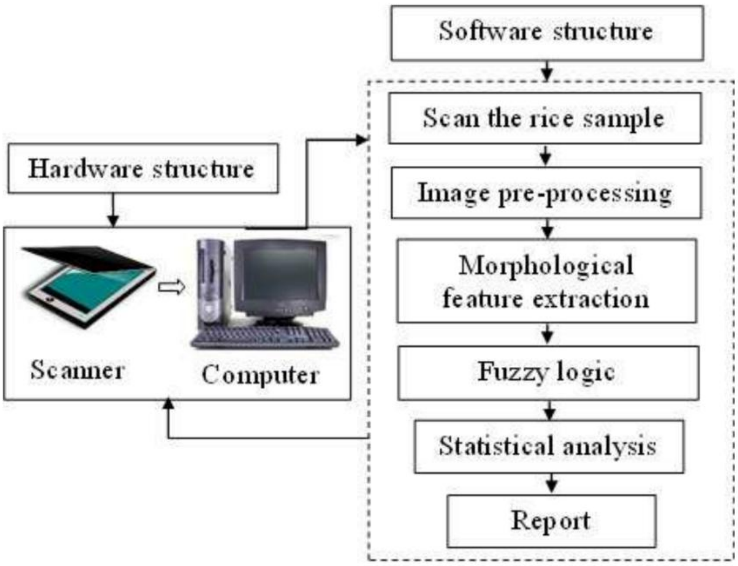


Figure 10: Structure of the identification of unmilled rice seed system

This study aims to propose a computerize method for unmilled rice seed identifying without seed destruction. The images of several rice seeds are recorded in computer via a scanner with RGB colour at 300×300 dpi. These colour images are used in RGB histogram analysis. In order to obtain shape and size of each rice seed, the edge detection is required. The RGB images are transformed into 256 Grayscale and Black and White colours, respectively. The edge detection then applied to the Back and White images in order to obtain shape, size and position of each seed. These information will used for geometry filler of seed. Then the fuzzy logic criteria are based on RGB histograms. Structure of unmilled rice seed identifying system is shown in Figure 10.

2.1.1 Hardware and software specification

1. Scanner : The Cannon MP 287 with the resolution at 300x300 dpi. A black paper is used background.
2. Computer : Compaq Presario V 3000 Intel Pentium Dual–Core 2.40 GHz inside with RAM 4 GB system type 32 bit.
3. MATLAB R2012b with self–coding.

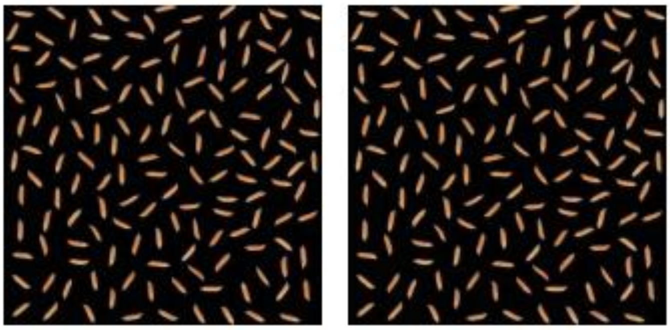
2.1.2 Rice seed samples and sampling

Two original samples of registered rice seeds of Jasmine rice 105 (J105) and sticky rice Kor Khor 6 (KK06) are taken from Ubonratchathani Rice Seed Center. According to the standard purity analysis, the amounts of 70g are needed which are responding to number of 1325 and 1,040 seeds of J105 and KK06, respectively, and named as sample I. It is used for fuzzy learning. Sample II, contains 600 seeds of J105 for tolerance testing. While sample III, contains 667 and 65 seeds of J105 rice and KK06, respectively, is used for methodology testing.

2.2 Images recording, colour transformations and edge detection

The unmilled rice seeds are separately placed on the scanner and then covers with a black paper. The image is set to 300×300 dpi in 24bit RGB system. There are total 9 images (5 for Jusmine rice + 5 for sticky rice) in fuzzy learning step, and 3 image of pure Jusmine rice in tolerance testing step, and 2 images for mixed sample in methodology testing. Figure 11 shows sample image in RGB colour which is imported via scanner.

Figure 11: The image in RGB colour



(A) (B)

Figure 12: The RGB image (A) and its transformed grayscale (B)

2.2.1 RGB to grayscale transformation

The 24bits RGB colour of input images are transformed to 8 bits grayscale colour. At any pixel point (x, y) of an image, the light intensities of red, green and blue colours are shown as integer numbers in range of 0 to 255 (8 bit in each colour of total 24 bit image). The transformation function f(x, y) represent the intensity in grayscale with obtain from intensities of red, green and blue colours at any pixel point is shown in equation (1), which is NTSC standard formula and is implied in rgb2gray function of MATLAB. Figure 11 shows example of RGB image and its transformed grayscale.

$$(x,y) = 0.299R(x,y) + 0.587G(x,y) + 0.114B(x,y) \tag{1}$$

Where

$f(x,y)$ = The intensity of grey colour at pixel point (x,y),
R(x,y) = The intensity of red colour at pixel point (x,y),
G(x,y) = The intensity of green colour at pixel point (x,y),
B(x,y) = The intensity of dark blue colour at pixel point (x,y).

2.2.2 Grayscale to black and white colour

The popular method of transformation black and white colour is simple function im2bw that uses intensity threshold as shown in equation (2). When f(x, y) is the value of intensity in grayscale (0–255).

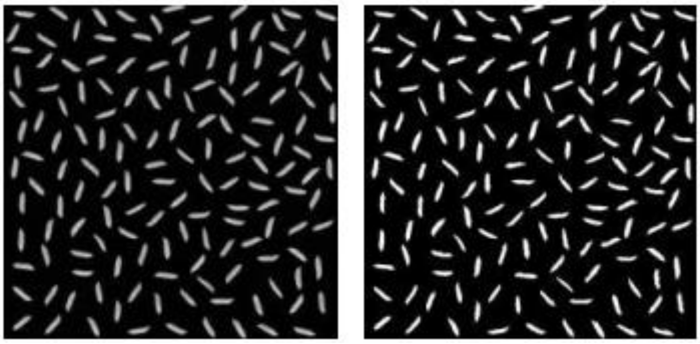
$$g(x,y)= f(x)=\begin{cases}1, \text{ if } f(x,y)>T, \\ 0, \text{ if } f(x,y)\leq T\end{cases} \quad (2)$$

Where

g(x,y) is the intensity of the black and white image at pixel point (x,y),

f(x,y) is the intensity of the image at point (x,y), and

T is the Threshold value used for separating the intensity level of the image, which is set to 0.2 in this study. Figure 13 shows example of grayscale image and its transformed black and white colour.



(A) (B)

Figure 13: The grayscale image (A) and its transformed black and white colour

2.2.3 Edge detection

The Canny edge detector method is employed via edge functions of MATLAB. It consists of 3 steps as following.

1. Do an image smoothing for reduction of disturbing signals by using gaussian smoothing filter.
2. Do gradient analysis for reduce the size of image edge.
3. Threshold determination for finding the pixel which is edge and edge connection is done.

Figure 14 shows an example of edge detections.

Figure 14: The image of edge detection

Figure 15: The image of physical calculated

The black and white colour with edge lines images are separately cut in to small size image for each seed. Then the physical properties, size, shape and area of the unmilled rice seed can be directly analyzed. Each pixel will have the value at 0 (background pixel) and 1 (seed pixel). The obtain ratio between area and diameter is used for physical filter, i.e. remove other seeds or inert matter. Figure 15 shows an example of physical properties.

2.3 Fuzzy logic inference

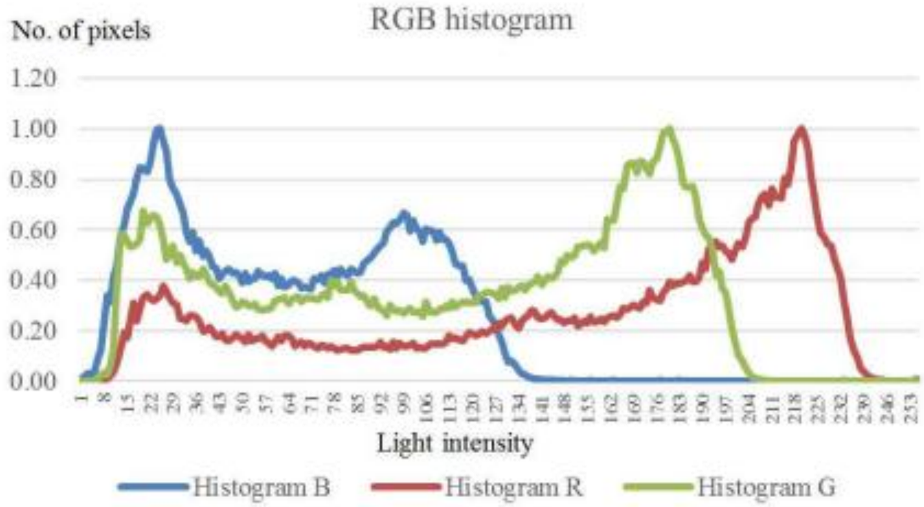


Figure 16: Distribution of RGB histograms for sample I

The production rules are obtained base on RGB histograms of all J105 and KK06 seeds in Sample I. The imgae histrogram of each colour provides the intensity values (0–255) and number of pixels for each intensity value. Since, the number of pixel can be big, for easy ploting, the ratio of number is introduced here. The ratio of number is the number of pixels in each intensity value divided by the maximum number of pixels of all intensity values. Since the red colour histograms of all seeds are wide and cover the blue and green histograms (Figure 16), the number of rules and rules interval–valued are based on red colour histograms. The average intensities of R, G, B of each seed are obtained with equation (3).

$$R = \frac{\sum_{i=1}^{n}(r[i]\times i)}{\sum_{i=1}^{n} i} \quad (2)$$

Where

i = showing a level of chroma,

n = a highest level of chroma which was equivalent to i level,

r[i] = a number of pixels having intensity of red light which was equipment, to the I level.

Then the maximum and minimum of average intensities of all seeds for each colour are obtained and used to define the total intervals. There are 5, 10, 15, 18, 20, 22 and 24 intervals without ranges overlapped are test in this study. Then in each rules, the interval ranges of blue and green intensities are considered with blue and green histograms of sticky rice seed. The interval ranges are chosen from the range that covers only Jusmin rice. Figure 17 shows the construction of 5 rules from the RGB histograms.

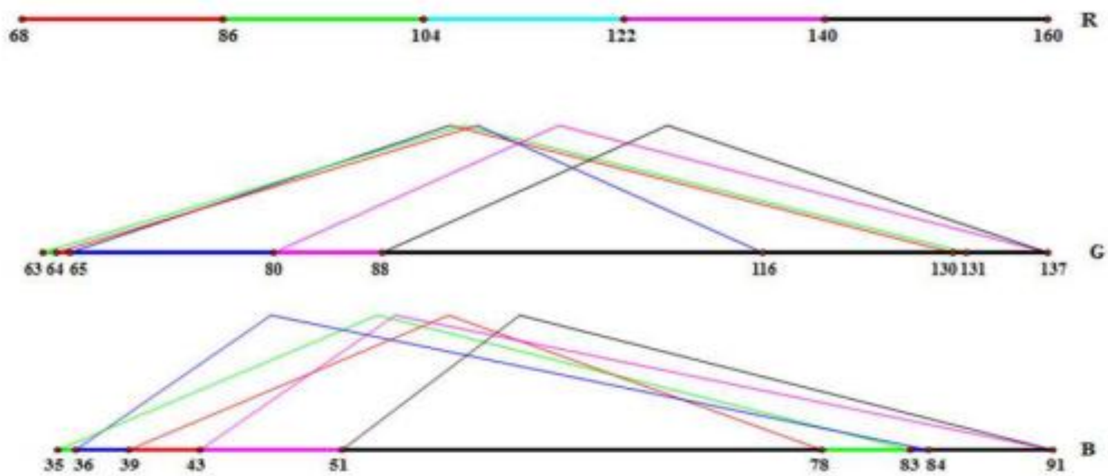
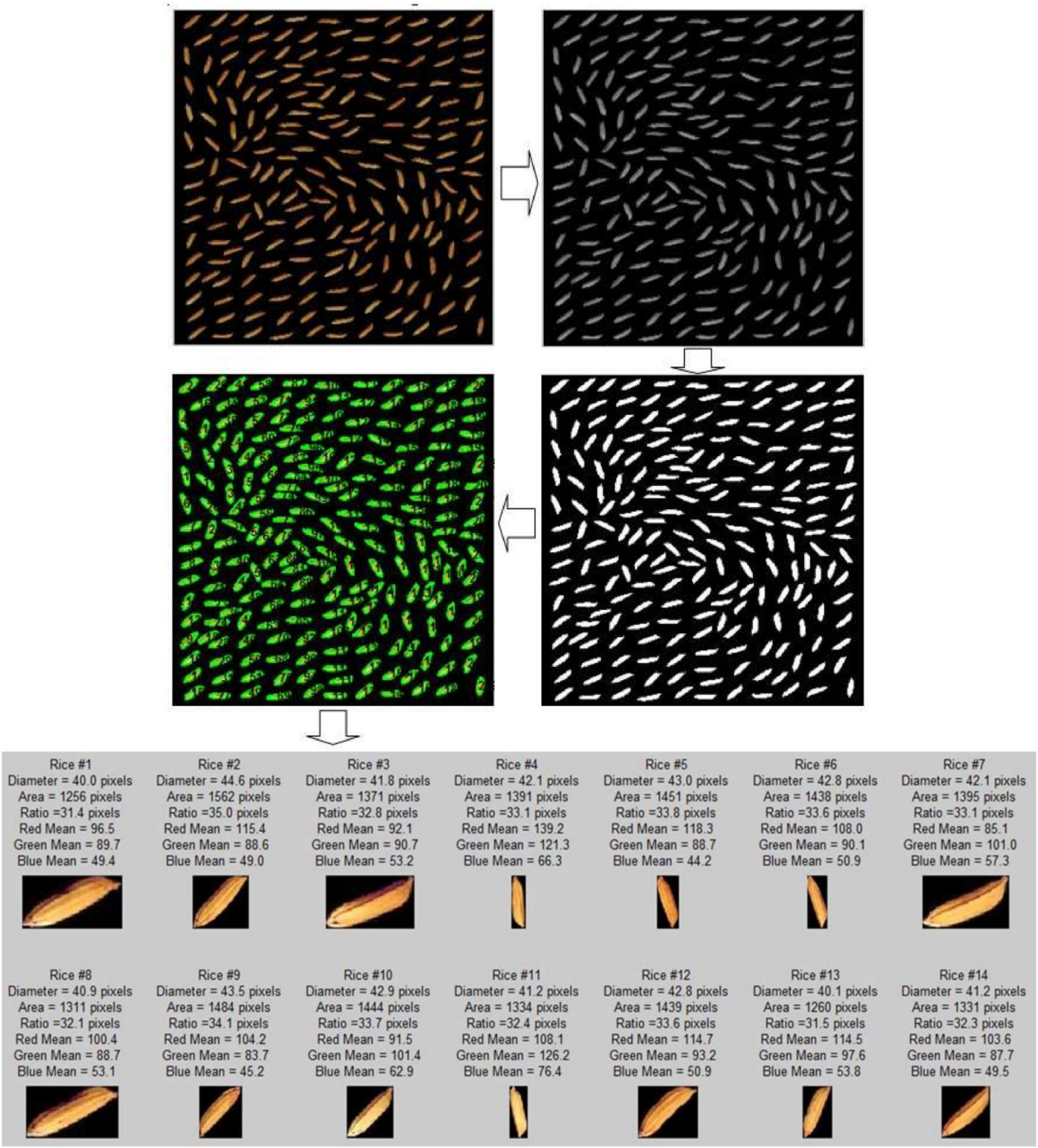


Figure 17: The construction of 5rules from the RGB histograms

3. Results and Discussion

3.1 Results

3.1.1 System resolution so as to be reference data for measuring the correctness



(A)

Figure 18: The colour transformations, edge detection, obtained area, diameter and RGB histograms of each seed, are shown for (A) Jusmine rice in Sample I

The Sample I, which contained subsamples of Jusmine rice and sticky rice seeds, is used in the training process. The maximum and minimum of area, diameter length, the ratio of area per diameter length and averages of RGB intensities are summarized in Table 3 The shape and size data is used in the criteria of other seed and inert matter removing. The minimum and maximum of RGB light intensities are used for defining fuzzy rules ranges.

Table 3: Maximum and minimum of area, diameter length, the ratio of area per diameter length and averages of RGB intensities

Rice strain	The physical data			Average of histogram light intensity		
	A	D	C	R	G	B
Jasmine rice 105	987-1630	35.4-45.6	27.8-35.8	68.7-158.9	63.9-137.8	35-91.3
Kor Khor 6	1041-1581	36.4-44.9	28.6-35.2	72.3-161.5	53.3-133.9	36.3-77.2

Where

A is the area of the unmilled rice seed,

B is the diameter length of the unmilled rice seed,

C is the ratio of area per diameter length,

R is the average of histogram R light intensity,

G is the average of histogram G light intensity,

B is the average of histogram B light intensity.

The images and histograms of Jusmine rice seeds which correspond to the minimum and maximum average RGB intensities (Table 3) are shown in Figure 19-21.

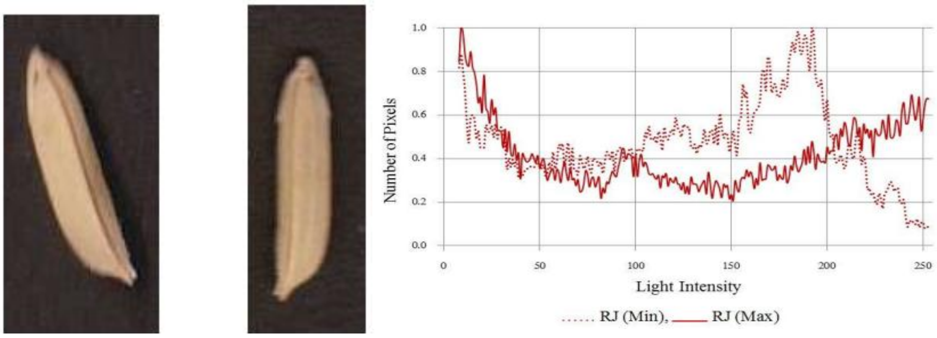


Figure 19: The seed images (A) and (B) correspond to the minimum and maximum average R light intensity, respectively, and (C) shows their histograms

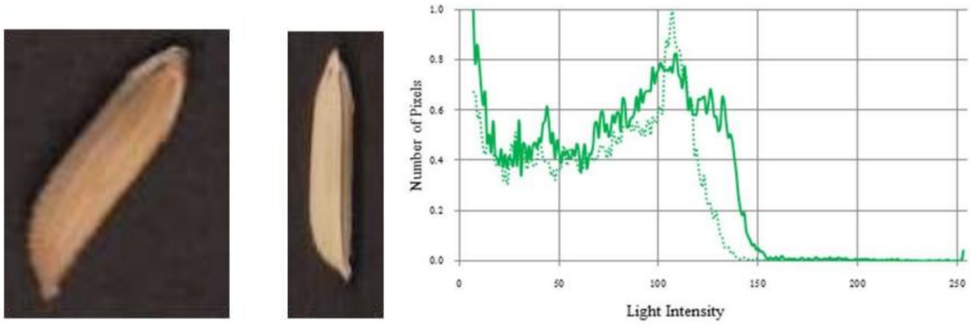


Figure 20: The seed images (A) and (B) correspond to the minimum and maximum average G light intensity, respectively, and (C) shows their histograms

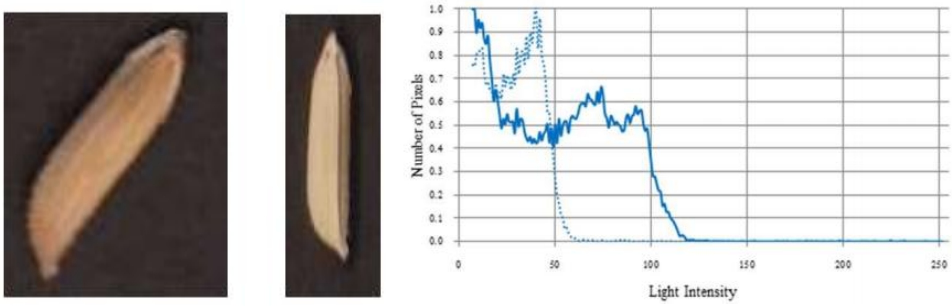


Figure 21: The seed images (A) and (B) correspond to the minimum and maximum average B light intensity, respectively, and (C) shows their histograms

3.1.2 Defining of fuzzy rules

According to Table 4, the minimum–maximum range of average R intensity is longer and covers the range of G and B colours. The main fuzzy rules set is defined base on R colour. The range of R intensity is equally divided to 5, 10, 15, 18, 20, 22, and 24 sub–ranges without overlapped, which correspond to the same number of trail rules. The ranges of G and B light intensities, then are defined in each rule with the ranges of Jusmine rice that exclude the ranges of sticky rice. Table 5 shows the identifying results after applied number of trail rules from 5 to 24 with Jusmine rices in Sample I (1,325 seeds).

Table 4: Criteria for identifying average R colour ranges of the pure strain of sample I.

List	Number of subdivisions						
	5	**10**	**15**	**18**	**20**	**22**	**24**
A number of rice seed passed criteria	**834**	**940**	**1,113**	**1,205**	**1,232**	**1,288**	**1,289**
A number of rice seed not passed criteria	**491**	**385**	**212**	**120**	**93**	**37**	**36**
% error	**37.06**	**29.06**	**16.0**	**9.06**	**7.02**	**2.79**	**2.72**

The result in Table 4 clearly shows that the %error of identifying is reduced when the number of rules is increased. However, the difference between 22 and 24 rules is quite small, to reduce the complexities of rules, then a set of 22 rules is applied in this study and is summarized in Table 5.

Table 5: The correctness values of histogram RGB light intensity dispersion of the sample I.

Criteria	Criteria of light intensity distribution value		
	$R(R_{(min)} – R_{(max)})$	**$G(G_{(min)} – G_{(max)})$**	**$B(B_{(min)} – B_{(max)})$**
1	68.7-90	86-114	54-74
2	90.1-95	83-130	50-85
3	95.1-100	83-113	48-85
4	100.1-103	85-120	49-74
5	103.1-105	82-110	45-65
6	105.1-107	80-116	43-61
7	107.1-108	84-115	43-66
8	108.1-109	84-112	48-72
9	109.1-110	87-115	48-72
10	110.1-110.5	87.5-100.5	46.9-58.7
11	110.6-111	82.9-105.3	44.4-59
12	111.1-111.5	86.8-107.4	48.7-66.2
13	111.6-112	89-106.9	50.2-61.9
14	112.1-113	87.4-124.9	50.5-80.8
15	113.1-114	90.1-114.4	49.1-64.4
16	114.1-115	87.1-111.4	47.9-67.2
17	115.1-117	89.6-116.5	49.1-71.4
18	117.1-119	93.1-127.4	52.7-83.4
19	119.1-121	96.2-113	53.4-65.1
20	121.1-125	95.2-124.2	49.6-74.6
21	125.1-130	91.4-123.6	51.8-73.9
22	130.1-160	95.6-145	50.6-89.9

3.2 Discussion

This study the computerized seed identifying for purity seed analysis of Jusmine rice 105 without seed destruction is proposed. The method is based on fuzzy logic criteria. The sets of rules are obtained using RGB histograms of the rice seed. The sample seeds of Jusmine rice and Kor Khor 6, are taken form Ubonratchathani Rice Seed Center and used for learning step, acceptable tolerance test and sensitivity and specificity test.

The images of rice seeds are recorded and imported into computer by scanner with black background. The original 24 bits RGB colour with 300x300 dpi images are transformed into 8 bits 256 levels Grayscale coulor and Back and White colours, respectively. The Black and White images are used for edges detection in order to obtain seed areas and positions. The big images are cut base on these edges into small images of each rice seeds. The physical criteria based on area, diameter length, and area per the length of diameter is used for removing other seeds and inert matter. The unmilled Jusmine rice 105 seeds have the area of 987–1630 pixels, the diameter length are of 35.4–45.6 pixels and the ratio of area per the length of diameter are 27.8–35.8. This criteria removed 3 seeds of all 732, which is only 0.004% of wrong identified. When a set of 22 fuzzy rules is applied, there are 656 seeds from total 667 seeds of Jusmine rice that correctly indentifying. There are 49 seeds from total 65 seeds of sticky rice that correctly identified.

4. Conclusion

This study can be a guideline for the identifying of unmilled Jasmine rice 105 based on image scanning. There is the computation of rice seed area, length of diameter, area ratio per length of the diameter, an average mean score of histogram RGB light intensity (non–destruction). This can be data for the farmer to make a decision to change new seeds for next cropping. However, the following are improvement. First, it is time consuming to place rice seeds which are not too close to each other since it is small in size. Thus, a rice seed placing equipment should be use for rapid image scanning. Second, to make it possible to be used in actual situation like in house or rice field, that without scanner or computer but with smart camera or mobiles.

5. Acknowledgments

The data of rice seeds are supported by Ubonratchathani Rice Research Center, Bureau of Research and Development, Thailand.

References

[1]. Rafael, C.G., and Richard, E.W. (2008). Digital Image Processing. New Jersey: Pearson Prentice Hall. 51.

[2]. Thai Rice Association. (2017). Rice Knowledge. Retrieved January 22, 2017, from http://www.thairiceassociation.com/index.php?&page=rice2content&groupid=27&topicid=38

[3]. Hobson, D.M., Carter, R.M., and Yan, Y. (2007). Characterization and Identification of Rice Grains through Digital Image Analysis. *Proceeding of Instrumentation and Measurement Technology Conference (IMTC 2007) on 1–3 May, 2007,* Warsaw University of Technology, Warsaw, Poland. Warsaw: Warsaw University of Technology.

[4]. Nation Bureau of Agricultural Commodity and food Standards Technical Standards Board. (2014). Good Agricultural Practices for Rice Seed: Thai Agricultural Standard 4406–2014. Nation Bureau of Agricultural Commodity and food Standards Ministry of Agriculture and Cooperatives. Retrieved January 22, 2017, from http://www.acfs.go.th/standard/download/GAP Rice seed.pdf

[5]. Nakonrat, P., Aunsrimuang, J., and Matthanang, N. (2011). The Study of the Assessment of the Rice Quality by Digital Image Processing of Rice Kernels. *Proceedings of the 5th UBU Conference on 4–5 Aug, 2011,* Ubon Ratchathani University, Ubon Ratchathani, Thailand. Ubon Ratchathani: Research Integration for Asian Community.

[6]. Guangrong, L. (2011). Detection of Chalk Degree of Rice Based on Image Processing Technique. *Proceeding of International Conference on Intelligence Science and Information Engineering (ISIE) on 20–21 Aug, 2011*, Wuhan Polytechnic University, Wuhan, China. Wuhan: Wuhan Polytechnic University. 50.

[7]. Fang, C., and Ying, Y. (2004). Machine vision inspection of rice seed based on Hough transform. *Journal of Zhejiang University SCIENCE,* 5(6), 663–667.

[8]. Ou Yang, A., Gao, R., Liu, Y., Sun, X., Pan, Y., and Dong, X. (2010). An Automatic Method for Identifying Different Variety of Rice Seeds Using Machine Vision Technology. *Proceeding of 2010*

Sixth International Conference on Natural Computation (ICNC 2010) on 10–12 Aug, 2010, Yantai University, Shandong, China. Shandong: Yantai University.

[9]. Punthumast, P., Auttawaitkul, Y., Chiracharit, W., and Chamnongthai, K. (2012). Non–destructive Identification of unmilled rice using digital image analysis. *Proceedings of the 9th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI–CON) on 16–18 May*, 2012, King Mongkut's University of Technology Thonburi, Phetchaburi, Thailand. Phetchaburi: King Mongkut's University of Technology Thonburi.

[10]. Dadwal, M., and Banga, V.K. (2012). Estimate Ripeness Level of Fruits Using RGB Color Space and Fuzzy Logic Technique. *International Journal of Engineering and Advanced Technology (IJEAT),* 2(1), 225–229.

[11]. Yao, Q., Zhou, Y., and Wang, J. (2010). An Automatic Segmentation Algorithm for Touching Rice Grains Images. *Proceedings of International Conference on Audio, Language and Image Processing (ICALIP2010) on 23–25 Nov, 2010,* Shanghai University, Shanghai, China. Shanghai: Shanghai University.