การพัฒนาระบบตรวจสอบคุณภาพทางฟีโนไทป์ของเมล็ดข้าวโดยใช้การเรียนรู้ของเครื่องจักร

Development of Rice Grain Phenotype Quality Verification System Using Machine Learning

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Abstract

The objectives of this research were (1) to examine the rice grain phenotype quality using machine learning by convolution neural networks (CNNs) techniques and (2) to examine the effectiveness of the rice grain phenotype program quality with the classified rice grain according to jasmine rice classification criteria under the Agricultural Product Export Act by creating rice grainy digital image. The samples obtained from Pathumthani Rice Research Center amounted to 2,150 images covering 4 jasmine rice groups, and using machine learning according to Auzuble Meaningful Learning Theory. (This theory states that meaning is created through some form of representation equivalence between language and mental context.) The proportion of practicing models and testing was 60:40. Calculated practicing examination of the rice grain quality model from 1,850 images was repeated in 25 testing model layers. The training efficiency model result was approaching 100 percent. After that, repeat training model of 1300 images with developed applications found the accuracy ratio to discover correct images from over all images at 0.907 and inaccuracy (F-measure) 0.028.

Keywords: quality verification system, rice grain phenotype, machine learning, convolutional neural networks, subsumption theory

บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์ (1) เพื่อตรวจสอบคุณภาพทางฟีโนไทป์ของเมล็ดข้าวด้วยการเรียนรู้ของเครื่องโดย

ใช้เทคนิคนิวรอลเน็ตเวิร์กคอนโวลูชัน และ (2) ตรวจสอบประสิทธิภาพของโปรแกรมตรวจสอบคุณภาพทางฟีโนไทป์ของเมล็ดข้าวจำแนกตามเกณฑ์การแบ่งกลุ่มข้าวหอมมะลิภายใต้พระราชบัญญัติการส่งออกสินค้าเกษตร โดยสร้างภาพดิจิตอลเมล็ดข้าวที่ได้จากศูนย์วิจัยข้าวปทุมธานี จำนวน 2,150 ภาพ ครอบคลุมข้าวหอมมะลิ 4 กลุ่ม ๆ ทำการสอนเครื่องจักรตามทฤษฎีการเรียนรู้อย่างมีความหมายออซูเบล แบ่ง สัดส่วนโมเดลฝึก: การทดสอบ เท่ากับ 60: 40 คำนวณโมเดลฝึกตรวจสอบคุณภาพข้าวด้วยภาพ 1,850 ภาพ ทำซ้ำ จำนวน 25 ชั้นการทดสอบ ได้ประสิทธิภาพของโมเดลฝึกเข้าใกล้ 100 เปอร์เซนต์ แล้วนำโมเดลฝึกไปทดสอบซ้ำด้วยภาพ 1,300 ภาพ โปรแกรมที่พัฒนาขึ้นมีอัตราส่วนของการค้นพบภาพที่ถูกต้อง (accuracy) ทั้งหมดจากจำนวนภาพที่มีอยู่ คือ 0.907 คลาดเคลื่อนของโปรแกรม (F-measure) คือ 0.028

คำสำคัญ: ระบบตรวจสอบคุณภาพ,ฟีโนไทป์ของเมล็ดข้าว, การเรียนรู้ของเครื่องจักร, นิวรอลเน็ตเวิร์กคอนโวลูชัน, ทฤษฎีการเรียนรู้อย่างมีความหมาย

Introduction

Thai rice was more widely known as agricultural products in the world. Especially, jasmine rice in Thailand. The phenotype of grain quality in the Thailand monitor by random check quality of the grain, which meet International Seed Association (ISTA), Thai agricultural stand TAS 4004-2017 was standard to control rice quality given by National Bureau of Agricultural Commodity and Food Standards by Ministry of Agriculture and Cooperatives, Government Gazette October 21, 2016 reliance agreed in the international market and promote rice exports have increased in value, But the forecast grain exports in 2019 in Thailand, Rice Exporters Association of Thailand expected to be decreased more than 2018 over the year with these factors was the volatility of the Baht, residues and contaminants in the rice, competition in the market because of high brand new mill or an exporter of rice production in the country, rice production and retail brands themselves. Finally, Thailand's rice consumption is lower than 95 kg per year fresh. Khaosod online (2018) a And more recently from the contest The World 's Best Rice, 2018 was organized by a group of business trade rice, fragrant rice from Angkor the country's gum in Cambodia has won the world best year 2018, But Thai rice part falls ranked 3. Thairath online (2018) the government must come back to review the unique quality of Thai rice since from production to help accelerate agriculture grind grill. They find ways or measures make Thai jasmine rice still quality and trust of international and came back as a national leader in this arena again.

Referring to the data above. Although inspection system carried out by the government the ride quality to supervise to the standards, But rice is also a problem due to the technology or expertise to monitor the quality have several limitations, the first abroad must be specialists with height experience in quality inspection the phenotypes of grain discover special in the company to rice production the export of rice Traders Association and government agencies that supervise, But the mill medium to small size was no expert help check the quality. Next, the issues of technology in quality inspection the phenotypes of grain with the use of these machines, start. From a simple tool was the vernier calipers, check 1 grain per time. Use by human, but takes a long time to practice, and work short time fatigue, and weary. Ghadge & Prasad (2012) Next, the large machines, such as sorting machine with camera and light grain "SORTEX S UltraVision" for international trade. Matichon online (2016), and the finals to a tool used in the laboratory such as machine NIR-SC-5000-1 / 2 (Digital Image Analysis System for. Grain) of Pathum Thani Rice Research Center, and a tool of technology Photonics technology center, electronic (NECTEC) The 3 machine consists of (1) Rice Scanner (S-Rice) (2) Rice Embryo Analyzer (A-Rice) and (3) Rice Classifier (C-Rice). Anchalee Prachetsuk. (2016, page, 61) Machines all kinds mentioned must all be used by experts, expensive, moving the inconvenience, and access to these technologies is difficult for farmers in general.

Thus, the limitations of technology and experts, but if we analyze the processes of all of the above technologies. Found that there was an input process similar input image capture of human eyes. Which input image the primary use of digital image processing of analyses phenotypic quality rice seeds. Which have many research about bringing this principle is applied to rice, such as Abirami, Neelamegam, and Kala (2014) Study Analysis of Rice Granules using Image Processing and Neural Network Pattern Recognition Tool. By bringing the grains placed on black, and then the shooting scene. Tanabata et al. (2012, pp. 1871-1880) Study SmartGrain: High-Throughput Phenotyping Software for Measuring Seed Shape through Image Analysis. To reduce the time of preparation, grain and capture. Mussadiq, Laszlo, Helyes, and Gyuricza. (2015) Study Evaluation and comparison of open source program solutions for automatic seed counting on digital images.

But the research mentioned found certain limitations, such as the work still to be done in a controlled environment, they must use tools consist of several parts in making a difficult move. And most importantly, still need to use only expert in the use of such a machine, Farmers would be difficult to reach.

So if there is a tool that is easy to use. Reduce limitation such as working area, accessory, and transport at the same time, and inexpensive. All the same can determine the quality similar of the grain phenotype professionals. From review research study found that the problems mentioned above. At present, this is bringing the science of artificial intelligence to help increase machine intelligence. The developer does not need to define a logic function can be fixed schedule of classes, according to a variety of problems. Phiraphon Tunjaya (2018) Monitoring grain standard to control rice quality given by Thai agricultural stand TAS 4004-2017 was information type Supervised Machine Learning (Muller, Guha, Baumer, Mimno, & Shami, 2016, pp. 3-8) Inconclusion, Machine learning to develop a system to monitor the quality of the phenotype of the grain, Solve the problem of certain limitation technologies mentioned above.

Research Objective

1. To examine the rice grain phenotype quality using machine learning by convolution neural networks (CNNs) techniques

2. Examine the effectiveness rice grain phenotype program quality to the classified rice grain according to jasmine rice classification criteria under the Agricultural Product Export Act By creating rice grainy digital image.

Literature Reviews

Image Processing

Image processing was a method to perform some operations on the image, in order to get an enhanced image or to extract some useful information from it. It was a signal processing in which input the image and output may be image or characteristics/features associated with that image. The basic principles and theory of digital image processing (Orachat Jitpakdee, 2009) improve accordingly the purpose of use in research in Thailand have example of such techniques, adapted as follows: Charnchai Namphon (2015) The Verifying of the Red Rice Seed Mixed in the White Rice Seed by Digital Image Processing Prasit Nakornra, Jurirat Ounsimung, and Napa-porn Matanang (2011) Instrument of rice quality from contaminations in milled rice by digital image processing Suchart Yammen, Narongrit Pimkumwong and Chocharat Lityean (2016) Classification of White Rice Seeds by Image Processing Poramate Porji et al. (2017) Classification of Thai Rice Seed Cultivars with Image Processing.etc. Research abroad for example Hanibah, Khairunniza-Bejo, Ismail, and Wayayok (2014) Determination of physical rice composition using image processing technique Kambo and Yerpude (2014) Classification of basmati rice grain variety using image processing and principal component analysis Liu et al. (2017) Rice and wheat grain counting method and software development based on Android system. Lurstwut and Pornpanomchai (2016) Application of image processing and computer vision on rice seed germination analysis Mebatsion, Paliwal, and Jayas (2013) Automatic classification of non-touching cereal grains in digital images using limited morphological and color features. And Tanabata, Shibaya, Hori, Ebana, and Yano (2012) SmartGrain: high-throughput phenotyping software for measuring seed shape through image analysis etc.

From related research. Summary of theory to digital image processing applied in monitoring grain quality phenotypic as follows Kulwadee Tanwong, Poonpong Suksawang, and Yunyong Punsawad (2018).

Algorithm: Recognition and Classification of rice grain image samples.

Input: Original 24-bit Color Image rice grains.

Output: Classified rice grains.

Step1: Acquire the rice grain images.

Step2: Crop individual rice grain and scale it.

Step3: Enhance image to remove noise and blurring.

Step4: Do the image segmentation.

Step5: Use these features to recognize and classify the rice grain.

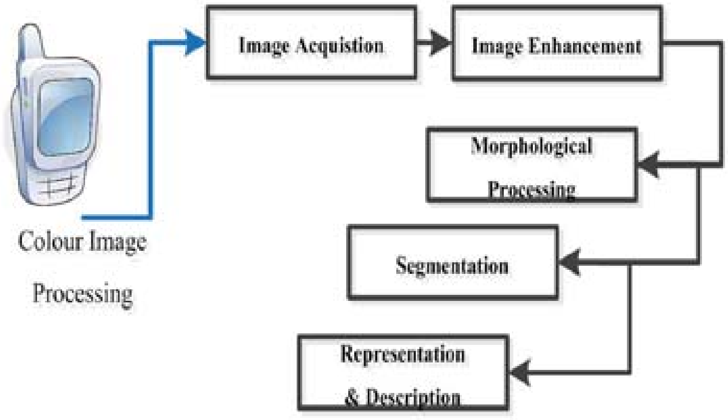

Figure 1 5 Step image processing

Scale-invariant feature transform (SIFT)

Detect and describe local features in images, and identifying matching keys from the new image. A modification for the best-bin-first search method that can identify the nearest neighbors with high probability using only a limited amount of computation. The BBF algorithm uses a modified search ordering so that bins in feature space are searched in the order of their closest distance from the query location. The nearest neighbors are defined as the key points with minimum Euclidean distance from the given descriptor vector. The probability that a match is correct can be determined by taking the ratio of distance from the closest neighbor to the distance of the second closest. To cluster identification by Hough transform voting. (Wikipedia, 2018)

SIFT process consists of 4 steps.

Step 1 Scale-space extrema detection)

Step 2 Key points localization

Step 3 Orientation assignment

Step 4 Key points descriptor

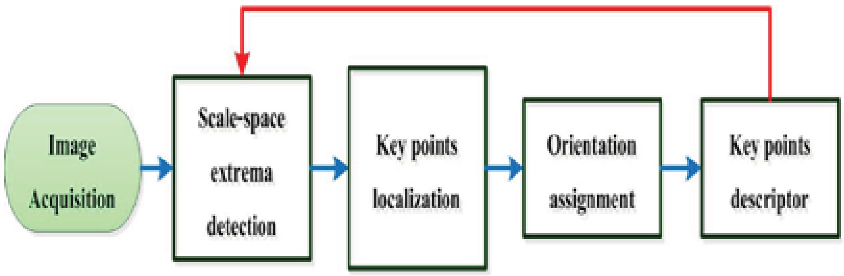

Figure 2 Example, related research: Olgun et al. (2016) Study Wheat grain classification by using dense SIFT features with SVM. Guo, Fukatsu, & Ninomiya, (2015) Study Automated characterization of flowering dynamics in rice using field-acquired time-series RGB images.

Classifier. Hong, Hai, Hoang, Hai, & Nguyen, (2015). Comparative Study on Vision Based Rice Seed Varieties Identification. And Rister, Wang, Wu, & Cavallaro, (2013) A Fast and Efficient SIFT Detector csing the Mobile GPU.

Research, above use Scale-Invariant Feature Transform (SIFT) feature detection algorithm finding the distinctive point of the image, Regardless of the size or direction of the object in the image features them from a similar object will have similar characteristics.

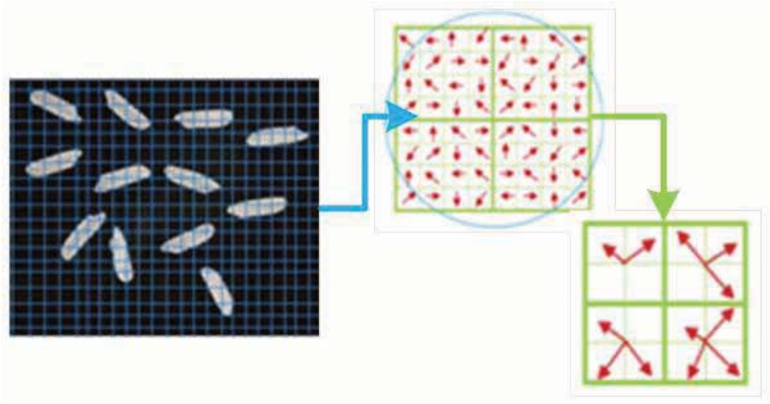

Figure 3 The process of generating the SIFT features

Machine Learning

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically comparison to the human brain without intervention or assistance and adjust actions accordingly. Combining machine learning with AI (Artificial Intelligence) and cognitive technologies can make it even more effective in processing large volumes of information.

Nevertheless, this research was supervised algorithms need to be trained with desired outcome data. Programmer input data analyst with machine learning skills to provide both input and desired output, in addition to furnishing feedback about the accuracy of predictions during algorithm training, variables, or features, the model should analyze and use to develop predictions called “Mearningful learning” follow Assimilation Theory. (Ausubel David, 1963) Once training is complete, the algorithm will apply what was learned to new data. agree with Nasrabadi (2007) Study Pattern Recognition and Machine Learning Describes the form of Machine Learning was the development of machine have the skills similarly humans such as Vision, Speech, Decision making, Emotions, etc. And Michalski, Carbonell, and Mitchell (2013) Said, Machine Learning was learning a variety of phenomena, the acquisition of new knowledge revealed. Increased the ability to learn practical skills such as. Brink et al., (2013) Study: Using machine learning for discovery in synoptic survey imaging data. Found that, classification methodology must use training data, making it easier to compile sufficient training sets for accurate performance in future surveys.

Machine learning type supervised learning witch were: Classification, Regression and Forecasting. This research must be operate classification rice grain standard to control rice quality given by THAI AGRICULTURAL STANDARD TAS 4004-2017.

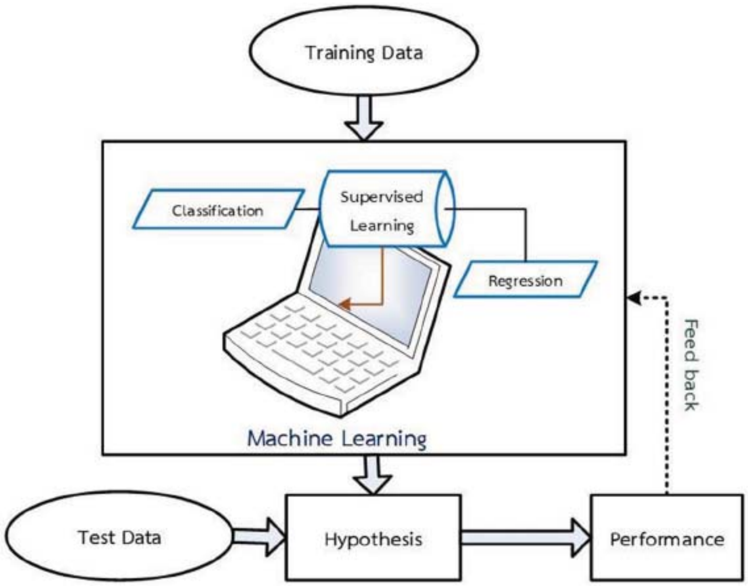

Figure 4 Machine learning type supervised learning

Algorithm

Bag-of-words model

The bag-of-words model were commonly used in methods of document classification where the (frequency of) occurrence of each word was used as a feature for training a classifier. In computer vision, change our "words" were now image patches and their associated feature vectors. Information Retrieval and text analysis, recording the number of times a given word appears in a document was trivially easy you simply count them and construction a histogram of word occurrences.

Convolutional Neural Networks: CNNs

CNNs the most popular neural network model being used for image classification problem, benefit fewer parameters greatly improves the time. It's takes to learn as well as reducing the amount of data required to train the model. Instead of a fully connected network of weights from each pixel, a CNN has just enough weights to look at a small patch of the image, same reading a book by using a magnifying glass; eventually, read the whole page, look at only a small patch of the page at any given time. e.g. Jmour, Zayen, and Abdelkrim (2018) "Convolutional neural networks for image classification" CNN to learn features and classify RGB-D images task. To determine the appropriate architecture, we explore the transfer learning technique called "fine tuning technique", of reusing layers trained on the ImageNet dataset in order to provide for four-class classification task of a new set of data. And Sharma, Jain, and Mishra (2018). "An Analysis of Convolutional Neural Networks for Image Classification." Prediction accuracy of three different convolutional neural networks (CNN) on most popular training and test datasets namely CIFAR10 and CIFAR100. From experiments, conclude that the performance of 27 layered networks was not much appreciated. Hence, more the number of layers, more will be the training and therefore, higher the rate of accuracy in prediction will be achieved, making a machine intelligent for solving many real-life object categorization problems.

Principal Component Analysis: PCA

A straightforward technique for reducing dimensions was Principal Component Analysis (PCA). The Embedding Projector computes the top 10 principal components. The menu lets me project those components onto any combination of two or three. PCA is a linear projection, often effective at examining global geometry.

Subsumption Theory Ausubel

The theory focuses on how individuals acquire and learn large chunks of information through visual means or text materials.

The 4 Key Principles of Subsumption Theory the following:

1. Instructor should be presented with general concepts first, and then their analysis.

2. The instructional materials should include new, as well as previously acquired information. Comparisons between new and old concepts are crucial.

3. Existing cognitive structures should not be developed, but merely reorganized within the learners' memory (Machine).

4. The role of the instructor was to bridge the gap between what's already known and what was about to be learne.

Research Framework

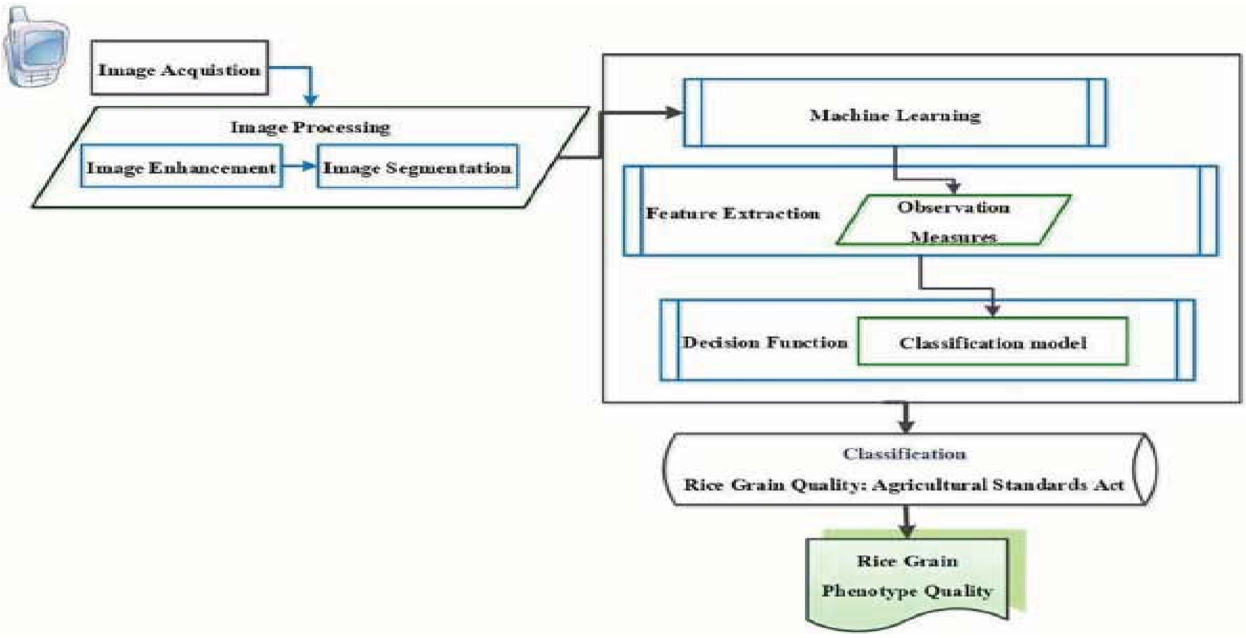

Figure 5 Development of Rice Grain Phenotype Quality Verification System

Research Method

The system design process to check the quality of the phenotypes of grain. Operational under the definition of the export standards act. Standard Thai Jasmine Rice (No. 3) in 2559 announced in the Royal Thai Government Gazette, the page 14 books 130 special Episode 14, consists of 2 part.

Part 1. Hardware: The device was used to create the digital data (image) Thai Agricultural Standard TAS 4004-2017 was standard to control of rice grain phenotype quality

1.1 The image processing hardware was a smart mobile phone, obtained from BBK Electronics Co, Ltd. (China). This module incorporates a Vivo V11 (2018) Dimensions

157.9 x 75 x 7.9 mm (6.22 x 2.95 x 0.31 in), Weight 156 g (5.50 oz), DISPLAY: Type Super AMOLED capacitive touchscreen, 16M colors Size6.41 inches, 100.9 cm2 (~85.2% screen-to-body ratio) Resolution 1080 x 2340 pixels, 19.5:9 ratio (~402 ppi density) OS Android 8.1 (Oreo), Chipset Qualcomm SDM660 Snapdragon 660 (14 nm), CPU Octa-core (4x2.2 GHz Kryo 260 & 4x1.8 GHz Kryo 260) GPU Adreno 512. These items make this ideal for fast prototyping, evaluation, and development of software for applications.

1.2 photographic equipment: smartphone handle stand for smooth light pass through taken object regularly, non-reflection, and background must harmonious with image shadow for reducing disturb signal after taken

1.3 standard bar for comparing objects use for compare real size objects inside taken image to finding rice grain size and grouping later

Part 2 software: developing on windows operating system by C++ write on Qt Creator Open CV

Scope of Research

1. Selection of seed rice (white rice):

From the company vendors jasmine rice. By the experts of Pathum Thani Rice Research Center operated selection every feature in the definition of Thai Agricultural Standard TAS 4004-2017.

Table 1

Standard Grade of grain according to Thai and US standards. Grain length in millimeters. The standard of agricultural products for export in 2016

A layer of white rice	Thailand (mm)	United States (mm)
1st Long Grade (Extra-long)	>7.0	>7.50
2nd Long Grain (Long)	6.6-7.0	6.61-7.50
3rd Long Grain (Medium)	6.2-6.6	5.51-6.60
4th Short Seeds	<6.2	<5.50

2. Change from natural materials into the form of digital information. To process digital image processing.

The image characteristics of rice grain to bring the machine learning can be calculated as follows.

$$C_{n,r} = \binom{n}{r} = \frac{n!}{(n-r)!r!} \quad (1)$$

A combination of things different N things. Select each time R things (10≤ r ≤ n)

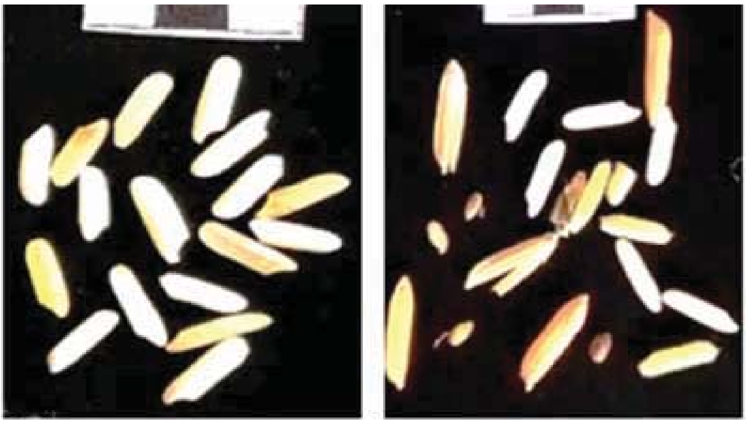

Figure 6 Input: Original 24-bit Color Image

3. Import the data from the second:

The characteristics of rice seeds criteria. Classification standard was each type, and the mixed together to create learning information

Divide image for Training and learning for Machine learning.

4. Import the data from the third:

Separate follow classification of standard criteria defined standard to control rice quality given by National Bureau of Agricultural Commodity and Food Standards to Machine learning.

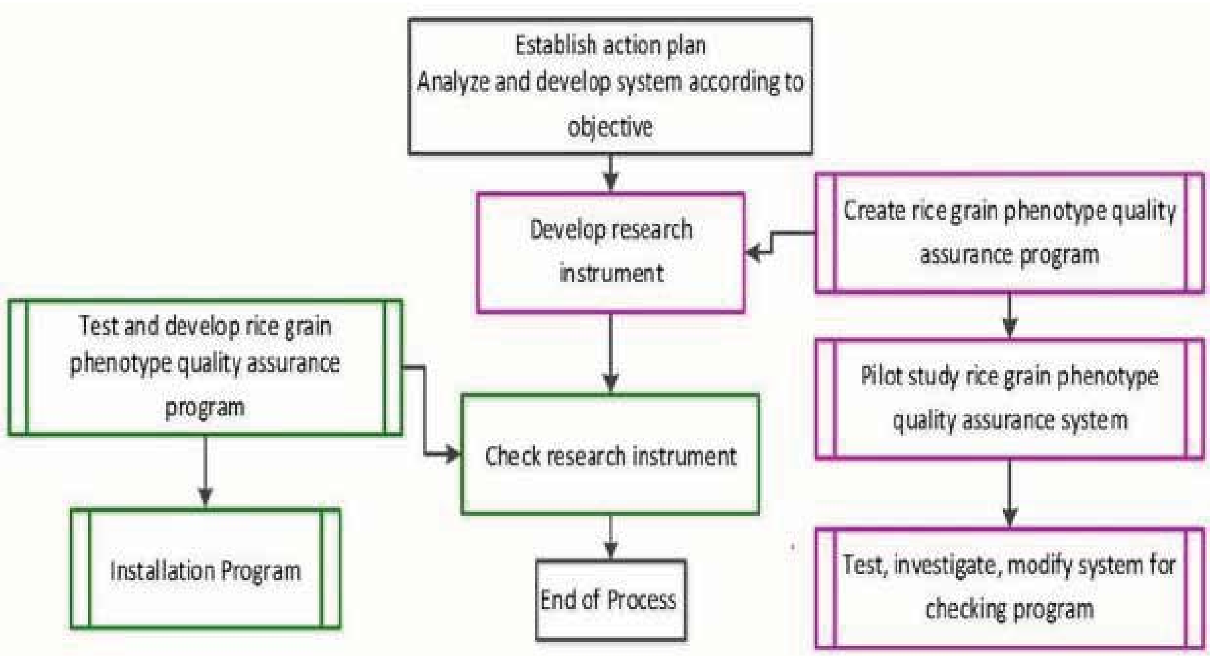

Figure 7 Scope of development of Rice Grain Phenotype Quality Verification System

Statistics in Research

Percent Error Formula

The formula was given by:

$$\frac{|\text{Approximate Value} - \text{Exact Value}|}{|\text{Exact Value}|} \times 100\% \quad (2)$$

(The "|" symbols mean absolute value, so negatives become positive)

Efficiency of Program

Root-Mean-Square

For a set of n numbers or values of a discrete distribution $x_i, \ldots, x_n$, the root-mean-square (abbreviated "RMS" and sometimes called the quadratic mean), was the square root of mean of the values x_i^2, namely

$$x_{RMS} = \sqrt{\frac{x_1^2 + x_2^2 + \ldots + x_n^2}{n}} \quad (3)$$

$$= \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}} \quad (4)$$

$$= \sqrt{\langle x^2 \rangle} \quad (5)$$

where (x^2) denotes the mean of the values x_i^2.

False Positive Rate/Precision: Pr

$$Pr = \frac{a}{(a+b)} \quad ,a+b>0 \quad (6)$$

True Positive Rate/Recall: Re

$$Re = \frac{a}{(a+c)} \quad ,a+c>0 \quad (7)$$

Accuracy: Acc

$$Acc = \frac{(a+d)}{(a+b+c+d)} \quad (8)$$

F-measure

$$F = \frac{2(Pr*Re)}{(Pr+Re)} \quad (9)$$

Results

Sample: Selected by Non–Probability Sampling using purposive random sampling method according to Agricultural Act. The sample classified by 25 rice characteristic created over all 2,150 images, anyway 1,850 images use for training flow rice 4 rice categories.

1. To examine the rice grain phenotype quality using machine learning by convolution neural networks (CNNs) techniques: Found that Microstructural similarity ranking

The bag of visual features microstructure representation also unlocks the potential for novel microstructural of rice grains

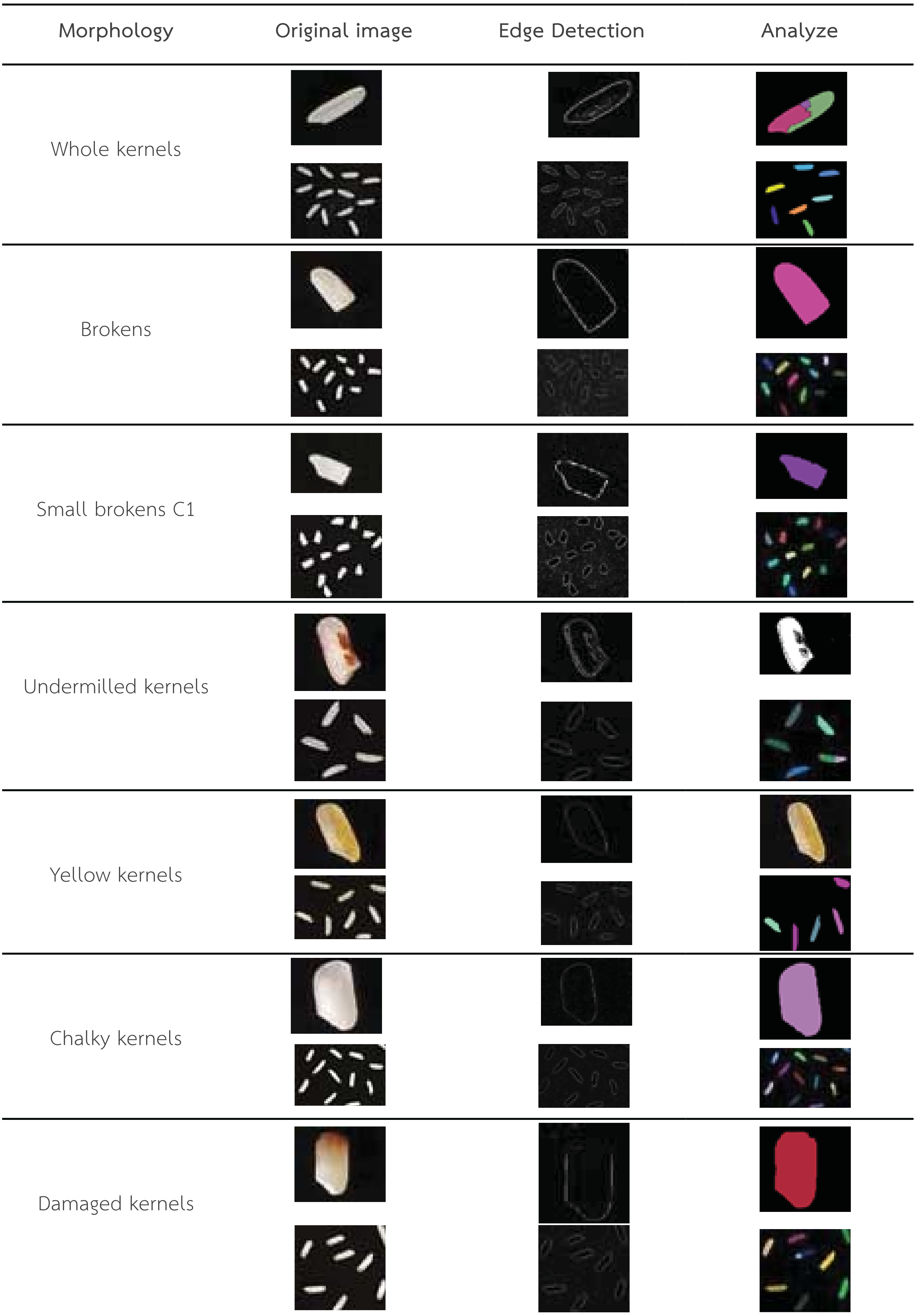

Figure 8 Example microstructures for the seven microstructure classes used in the classification test, all 14 annealing twin images.

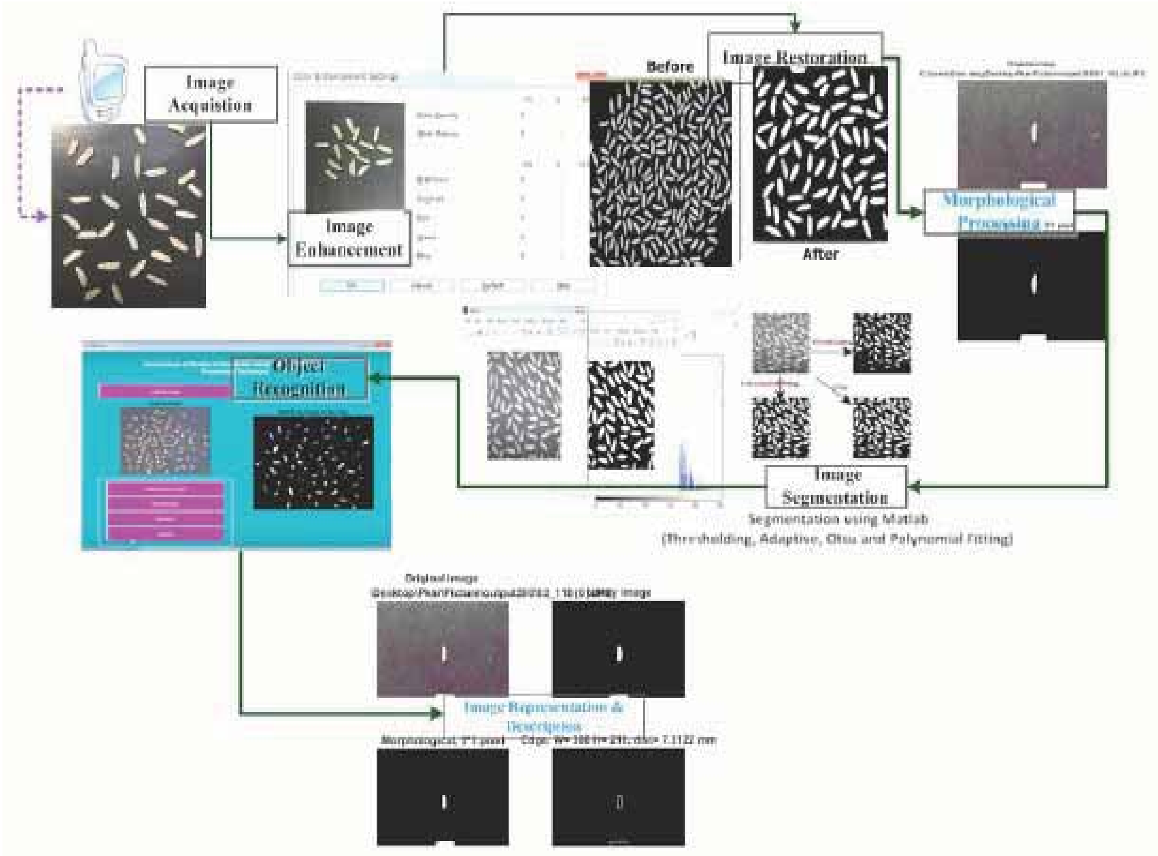

Figure 9 Prepare Image Bring to Process Machine Learning using by CNNs Technique.

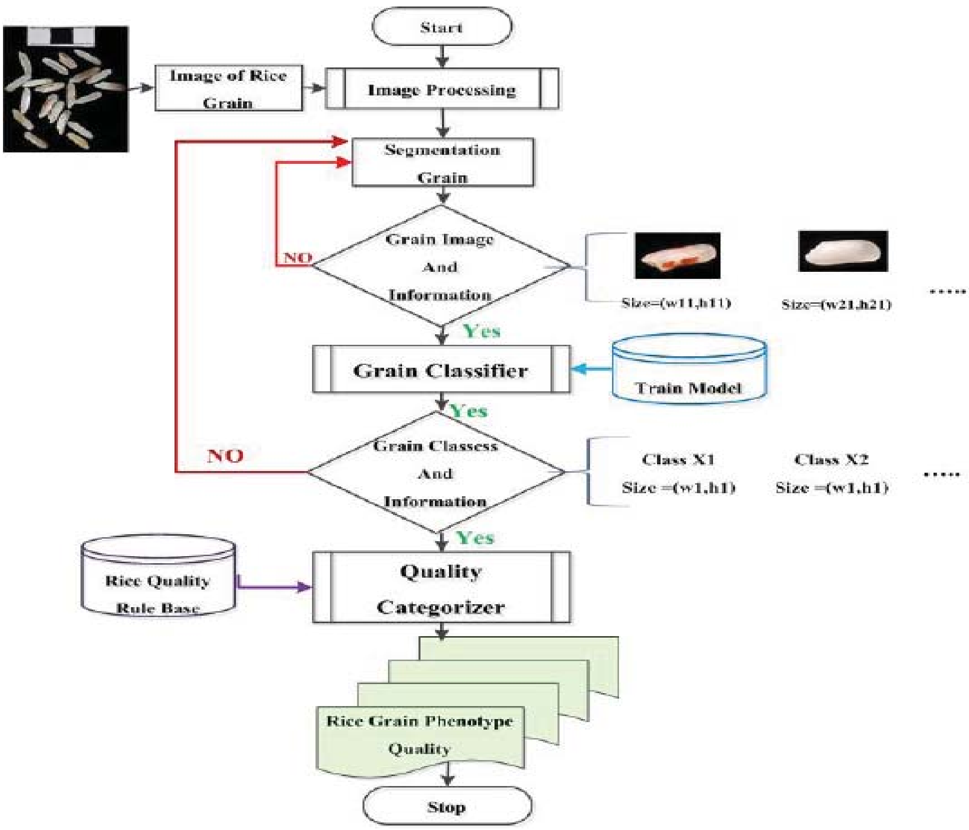

Figure 10 Determining Quality of the Phenotype Grain by Machine Learning using CNNs Technique.

Table 2

The results generated from the proposed algorithm as visualized with a confusion matrix. (5x5 confusion matrix)

Group number	Correct classification	Group number	Correct classification
G1	140/150	G14	133/150
G2	150/150	G15	100/150
G3	144/150	G16	115/150
G4	135/150	G17	114/150
G5	125/150	G18	139/150
G6	150/150	G19	143/150
G7	149/150	G20	148/150
G8	150/150	G21	150/150
G9	132/150	G22	123/150
G10	122/150	G23	131/150
G11	111/150	G24	139/150
G12	147/150	G25	150/150
G13	150/150		

correct classified images = 3390

total test images 3750 = (25 * 150)

Accuracy = 90.4%

2. Examine the effectiveness rice grain phenotype program quality to the classified rice grain according to jasmine rice classification criteria under the Agricultural Product Export Act By creating rice grainy digital image.

Figure 11 Shows the measurement of the effectiveness of the classification program using criteria according to Agricultural Act.

Table 3

Accuracy of the rice grain phenotype quality system inspection program

Group rice		Predicted			
		100%	5%	10%	15%
Actual	100%	31	1	0	2
	5%	3	31	5	5
	10%	4	3	30	8
	15%	2	5	5	25
Accuracy		0.907			

Recall/ True Positive Rate: Classified as follows

Recall Rice 100% = 0.775

Recall Rice 5% = 0.775

Recall Rice 10% = 0.75

Recall Rice 15% = 0.625

Precision/ False Positive Rate: Classified as follows

Precision Rice 100% = 0.912

Precision Rice 5% = 0.705

Precision Rice 10% = 0.667

Precision Rice 15% = 0.676

Accuracy: Ratio of finding all the correct images from the number of images available. = 0.907

F-measure = 0.028

Table 4

The error of investigate the accuracy of the jasmine rice counting program

Group White rice	Error (N=4000 Grain)	AVG: Error	%Error	RMSE
White rice 100%	3	0.075	0.3	0.11
White rice 5%	5	0.125	0.5	0.25
White rice 10%	6	0.15	0.6	0.35
White rice 15%	8	0.20	0.8	0.42

Found that 15% white rice with the most errors of 0.8% and 100% white rice with error of 0.3% least, and the error of prediction (RMSE) 100% white rice misses the least.

Table 5

The error of investigate rice grain phenotype program quality to the classified rice grain according to jasmine rice classification criteria under the Agricultural Product Export Act

Group White rice	Error (N=4000 Grain)	AVG: Error	%Error	RMSE
White rice 100%	9	0.225	0.9	0.53
White rice 5%	9	0.225	0.9	0.46
White rice 10%	10	0.25	1	0.71
White rice 15%	13	0.33	1.3	0.74

Found that 15% white rice with the most errors of 1.3% and 100% white rice with error of 0.9% least, and the error of prediction (RMSE) 5% white rice misses the least.

Discussion

The development of the rice grain phenotype quality inspection program in the field of application has been tested with the products sold in Thai market. The development of the program brings the concept of Ozubel. (Assimilation Theory) is a concept that helps teach Machine learning (Machine) in answering wrong or incorrect questions And results to improve teaching to improve the model to be more accurate By looking at the amount of wrong answers In order for the next round to be less and less wrong, consistent with Mohsen et al's research, 2018 "pulling out the important points of the image, making the grouping more accurate" and Zavitsanos, Paliouras, Vouros, and Petridis, 2010 that brought "Subsumption Theory to help create a taxonomy (ontology of rice)". As the result of the following research:

Examine program accuracy by counting the amount of rice grain in each image between human counting and the program found that, 100% white rice group inaccuracy average was 0.075 or 0.75 percent, white rice 5% inaccuracy average was 0.125 or 1.25 percent, 10% white rice group had inaccuracy average was 0.150 or 1.5%, white rice group 15% inaccuracy average was 0.2 or 2%. The obtained results Root Mean Square Error (RMSE) was range 0-1, found that 15% white rice classification was the highest inaccuracy was 0.42. Anyway, the highest inaccuracy result was acceptable according to criteria.

Examine the accuracy of rice grain phenotypic classification program in each rice grain. The prerequisites between the experts and the program found that the 100% white rice inaccuracy was 0.225, or 2.25 percent. White rice 5% inaccuracy was 0.225 or 2.25%, white rice 10%, inaccuracy was 0.25 or 2.5%, white rice 15%, inaccuracy was 0.33 or 3.33%. The obtained results Root Mean Square Error (RMSE) was range 0-1, found that 15% white rice classification was the highest inaccuracy was 0.74 Anyway, the highest inaccuracy result was acceptable according to criteria

Conclusion

In this research, reported a new approach to identify the development of rice grain phenotype quality verification system, the implemented system to make the classification of Thai jasmine rice objects with an effortless way and without losing the time.

The classification of rice grains requires techniques that create learning. For learning techniques that increase the efficiency of creating a computer to distinguish sounds, objects, characters, or classifying large amounts of information that cannot be done by humans Research has been done by Mitchell, 1997 and Indolia, Goswami Mishra, and Asopa, 2018 which have chosen Convolution Neural Networks (CNNs).

"CNN was a profound learning method used widely to solve complex problems. It overcomes the limitations of traditional learning methods. Whether was a smart, intelligent classification reducing the number of parameters to be as well as necessary? Which this research uses such techniques to find the accuracy ratio to discover image from over all image 0.907 and inaccuracy (F-measure) 0.028

Recommendation

The cause of the error come from:

1. Overlapped or Stick together

2. Shooting angle/Distance

3. Light

Therefore, develop parallel with hardware and program to reduce the occurrence of the above error.

References

Abirami, S., Neelamegam, P., & Thanjavur India, K. H. (2014). Analysis of rice granules using image processing and neural network pattern recognition tool. *Intrnational Journal of Computer Applications, 96*(7), 20-24.

Ausubel, D. P., & Youssef, M. (1963). Role of discriminability in meaningful paralleled learning. *Journal of Educational Psychology, 54*(6), 331.

Brink, H., Richards, J. W., Poznanski, D., Bloom, J. S., Rice, J., Negahban, S., & Wainwright, M. (2013). Using machine learning for discovery in synoptic survey imaging data. *Monthly Notices of the Royal Astronomical Society, 435*(2), 1047-1060.

Ghadge, P., & Prasad, K. (2012). Some physical properties of rice kernels: Variety PR-106. *Journal of Food Process Technology, 3*(8), 1-5.

Guo, W., Fukatsu, T., & Ninomiya, S. (2015). Automated characterization of flowering dynamics in rice using field-acquired time-series RGB images. *Plant methods, 11*(1), 7.

Hanibah, S. S. B., Khairunniza-Bejo, S., Ismail, W. I. W., & Wayayok, A. (2014). Determination of physical rice composition using image processing technique. *Journal of Food, Agriculture and Environment, 12*(1), 205-209.

Hong, P. T. T., Hai, T. T. T., Hoang, V. T., Hai, V., & Nguyen, T. T. (2015). Comparative study on vision based rice seed varieties identification. Paper presented at the Knowledge and Systems Engineering (KSE-2015). *7th International Conference in Ho Chi Minh City*, Ho Chi Minh.

Jitpakdee, O. (2009). *Digital image processing*. Bangkok: Sakhonkit Printing & Media.

Jmour, N., Zayen, S., & Abdelkrim, A. (2018). Convolutional neural networks for image classification. *In 2018 International Conference on Advanced Systems and Electric Technologies*, Hammamet

Khaosod. (2018). *Private point of Thai rice situation deteriorated. Expected years' 62 export only 10 million tons*. Retrieved from https://www.khaosod.co.th/economics/news_1803094

Liu, T., Chen, W., Wang, Y., Wu, W., Sun, C., Ding, J., & Guo, W. (2017). Rice and wheat grain counting method and software development based on Android system. *Computers and Electronics in Agriculture, 141*(1), 302-309.

Lurstwut, B., & Pornpanomchai, C. (2016). Application of image processing and computer vision on rice seed germination analysis. *Int. J. Appl. Eng. Res, 11*(1), 6800-6807.

Mebatsion, H., Paliwal, J., & Jayas, D. (2013). Automatic classification of non-touching cereal grains in digital images using limited morphological and color features. *Computers and Electronics in Agriculture, 90*(1), 99-105.

Michalski, R. S., Carbonell, J. G., & Mitchell, T. M. (2013). *Machine learning: An artificial intelligence approach*. Berlin: Springer Science & Business Media.

Muller, M., Guha, S., Baumer, E. P., Mimno, D., & Shami, N. S. (2016). Machine learning and grounded theory method: convergence, divergence, and combination. *Paper presented at the Proceedings of the 19th International Conference on Supporting Group Work*, Florida.

Mussadiq, Z., Laszlo, B., Helyes, L., & Gyuricza, C. (2015). Evaluation and comparison of open source program solutions for automatic seed counting on digital images. *Computers and Electronics in Agriculture, 117*(1), 194-199.

Nakornra, P., Ounsimung, J., & Matanang, N. (2011). Instrument of rice quality from contaminations in milled rice by digital image processing Poramate porji et al. *In 5th Research Conference on Integrating Research into the ASEAN Community*, Ubon Ratchathani.(in Thai)

Namphon, C. (2015). The verifying of the red rice seed mixed in the white rice seed by digital image processing. *Journal of Industrial Technology Ubon Ratchathani Rajabhat University, 5*(1), 59-71.

Nasrabadi, N. M. (2007). Pattern recognition and machine learning. *Journal of electronic imaging, 16*(4), 049-901.

Olgun, M., Onarcan, A. O., Özkan, K., Işik, Ş., Sezer, O., Özgişi, K., ...Koyuncu, O. (2016). Wheat grain classification by using dense SIFT features with SVM classifier. *Computers and Electronics in Agriculture, 122*(1), 185-190.

Rister, B., Wang, G., Wu, M., & Cavallaro, J. R. (2013). *A fast and efficient SIFT detector using the mobile GPU.* Retrieved from https://www.researchgate.net/publication/236611667_A_Fast_and_Efficient_SIFT_Detector_using_the_Mobile_GPU

Sharma, N., Jain, V., & Mishra, A. (2018). An analysis of convolutional neural networks for image classification. *Procedia Computer Science, 132*(1), 377-384.

Tanabata, T., Shibaya, T., Hori, K., Ebana, K., & Yano, M. (2012). *SmartGrain: high-throughput phenotyping software for measuring seed shape through image analysis.* Retrieved from http://www.plantphysiol.org/content/160/4/1871

Thairath. (2018). *Cambodian rice 'Mali Angkor' the best rice in the world championship, squeeze Thai rice.* Retrieved from https://www.thairath.co.th/content/1398546

Tunjaya, P. (2018). User Experience Design of Artificial Intelligence Technology. *EAU Heritage Journal Science and Technology, 12*(1), 39-46. (in Thai)

Wikipedia. (2018a). *Machine learning.* Retrieved from https://en.wikipedia.org/wiki/ Machine learning

Wikipedia. (2018b). *Scale-invariant feature transform (SIFT).* Retrieved from https://en.wikipedia.org/wiki/Scale-invariant_feature_transform

Yammen, S., Pimkumworng, N., & Lityean, C. (2016). Classification of white rice seeds by image Processing. *Journal and Research Rajamangala University of Technology Pranakon, 10*(1), 1-13. (in Thai)