AUTOMATED IMAGING SYSTEM FOR DETERMINE PERCENTAGE OF BROKEN RICE

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ABSTRACT

Automated Imaging System for Determine Percentage of Broken Rice project is focusing on analyzing the method of determination of broken rice and to develop a prototype of imaging system for determines the percentage of broken rice referring to the conventional method. Broken rice is rice that broke into another pieces that make it smaller than other normal rice. It is due to many aspect such as milling process, the drying process and so many more. This will reduce the quality of rice produced. Hence this Automated System for Determine Percentage of Broken Rice Prototype developed to control the quality of rice that produced which is focused on broken rice. In the result of the project this prototype will show the percentage of broken rice that being measured so that the user can control the process of producing the rice from paddy so that less broken rice are produced and high quality of rice will be delivered to consumer. According to the testing results, this system has met its objectives whereby system able to identify the percentage of broken rice similar to the conventional method with the precision of 98.00%.

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ABBREVIATIONS

PPK	-Pertubuhan Peladang Kawasan
DOM	-Degree of Milling
JPEG	- Joint Photographic Experts Group
SLAP	- Surface Lipid Area Percentage
SLC	- Surface Lipid Concentration
CCD	- charge-coupled device
PPI	-Pixel Per Inch
PNG	- Portable Network Graphics
PCX	- Personal Computer eXchange
RAD	- Rapid Application Development

CHAPTER 1

INTRODUCTION

1.1 Introduction

Rice is a special type of grass that is also known as cereal. It has been grown in China for 5000 years and is known to be one of the oldest foods known to man [1]. Rice provides of global human energy and protein. Although rice protein ranks high in nutritional quality among cereals, protein content is modest. Rice also provides minerals, vitamins, and fiber, although all constituents except carbohydrates are reduced by milling [2]. Apart from that, rice is healthful for what it does not contain. Rice has no fat, no cholesterol, low sugar and is sodium free. Rice is an excellent food to include in a balanced diet. The vitamins in rice is such as thiamine, niacin, iron, riboflavin, vitamin D, calcium, and fiber give a healthier diets and experience better health to the rice eaters [3]. In addition whole grains (such as brown rice) contain high amounts of insoluble fiber-the type of fiber some scientists believe may help protect against a variety of cancers [4].

Rice is also the most important crop to millions of small farmers who grow it on millions of hectares throughout the region, and to the many landless workers who derive income from working on these farms. Rice research that develops new technologies for all farmers has a key rôle to play in meeting this need and contributing to global efforts directed at poverty alleviation [5] [6].

There are many efforts that have been conduct to enhance the quality and quantity of rice yield to cover the need of rice in nowadays world. Even though many efforts have been done, but the amount of rice is still not enough to cover the needs of people. This is happened due to many aspects such as weather, land of paddy plantation, paddy disease, technology and so many more [7].

Apart from that, quality of rice that that produced is not less important. As a consumer, we tend to take the good quality of rice. Quality of rice produced in a rice factory is depending on many aspects. One of its aspects is in percentage of broken rice. Broken rice is the rice that broke while in milling process [8]. The quality of rice is depending on how much percentage of broken rice is yield. The higher the percentage of broken rice produced the less quality it is. Nowadays, the conventional method is used to determine the percentage of broken rice which is by using micrometer to separate the broken rice and the normal rice in a fixed quantity [9]. It is not productive and cost lot of time. By using Image processing method, this process will become more productive as less time taken to determine the percentage of broken rice. If the percentage of broken rice is high, the system will prompt the worker to adjust the milling machine so that the percentage of broken rice lowered. Apart from that, nowadays system cannot monitor the quality of rice in every time due to no system had implemented to monitor the quality of rice produced throughout the process of milling. By using Image Processing, the process can be monitored regularly.

1.2 Problem Statement

There is several problem and weakness that arose from conventional method to determine the percentage of broken rice. Below are state the problem that faced:

Conventional method is less productive and lot of time consuming. Nowadays, conventional method is still used to determine the percentage of broken rice. The conventional method used by taking a fixed quantity of rice that been processed and then by using micrometer, the worker will measure the rice and then come out with the result. This method consumes a lot of time and waste of human energy. This method is less productivity.

Apart from that there is no specific method or system that monitors the quality of rice processed. The conventional method cannot monitor the quality of rice produced. The broken rice produced is depending on many aspects. For example, if the rice is to dry it will tend to broke easily. By using conventional method, workers cannot monitor it regularly because it is tiring.

In addition the time of rice cooked is not same due to the present of broken rice. The time taken to cook single rice is different with the size. The normal kernel (rice) will cooked in a specific time while the broken rice will cooked at lower time. Therefore, when someone cook rice, the cooks are not perfect as the broken rice is overcooked.

1.3 Objective

There are two objectives to be achieved in this project:

i) To analyze the method of determine the percentage of broken rice.
ii) To develop a prototype of imaging system for determines the percentage of broken rice yield in milling process.

1.4 Project Scope

The scope for this project is defined as below:

i) Technology used to develop prototype is scanner from hp product (hp F2480) and computer (Laptop Acer 4920)
ii) Technique that used is image processing technique to determine the percentage of broken rice with 1700 X 2338 pixels of image size and .jpg as format of the picture.
iii) Locale (Case Study) of this study is kilang padi PPK Kangkong, Pasir Mas Kelantan.

iv) Restriction for this project is the object taken as image is white rice, the rice did not attach to each other and lighting is always constant. Last but not least the rice that being measured must be from "beras jati" type.

v) Three type off broken being measured which are "super special" broken, "extra super" broken, and "super" type broken.

1.5 Thesis Organization

Chapter 1 gives an overview of current problem that will be used as case study for this project. Apart from that, this chapter also introduce the current system of determines the percentage of broken rice and suggest new method of solving the problem by using image processing. This chapter includes the introduction, problem statement, objective, project scope, and thesis organization.

Chapter 2 will discuss about the current system used to solve the problem discussed in chapter 1 and the studies of devices and tools that will be used in this case study. This includes the introduction, studies on existing system, development tools, studies on devices, and conclusion.

Chapter 3 will discuss about the method and ways of developing the new system for determination of percentage of broken rice. This includes the introduction, software methodology, software and hardware requirement, and conclusion.

Chapter 4 will discuss about the implementation of system prototype. This includes the image acquisition, image enhancement, feature extraction, determination percentage of broken rice, global declaration for print result, and insertion data to database and conclusion.

Chapter 5 will discuss about the result and discussion of thesis. This include the introduction, image acquisition, image enhancement, feature extraction, determine percentage of broken rice, test result, advantages and disadvantages, constraints, and assumption and further research.

Chapter 6 will discuss about the conclusion of thesis. The conclusions for each chapter are discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Automated Imaging System for Determine Percentage of Broken Rice is a system that will calculate the percentage of broken rice yielded in the end of milling process. Broken rice or known as broken Kernel is the rice that broke in milling process [10]. The breakage is dependent on the variety, size and shape of grains, the existence of pearl [11], the rate and time of nitrogen application as well as on the cylinder speed of threshing. It is significantly affected by the weather conditions prevailing just before the harvest and by the grain moisture content during harvesting [12]

Apart from that, broken rice yielded is also related with polishing of rice which happened in milling process. Moisture changes can induce tensile and compressive stresses within the kernel, which often lead to stress crack development [13].

Moreover, the thermal and material properties of rice kernel change depending on the temperature and moisture gradients generated during processing. The fissured kernels break easily during milling [14]. Considerable work has been done on optimizing the milling yield by choosing suitable harvesting time, harvest moisture content, and drying temperatures.

Table 1. Analysis of variance of total milling yield and grain breakage as affected by five rice varieties and six harvest times

Source	df	Mean squares: Total milling yield	Mean squares: Grain breakage
Year	1	147.74**	608.34 **
Variety	4	454.21**	337.63 **
Year x Variety	4	3.00**	28.55 **
Error	27	0.59	0.59
Harvest time	5	45.31**	766.02 **
Year x Harvest time	5	17.05**	24.41 **
Variety x Harvest time	20	2.71**	20.89 **
Year x Variety x Harvest time	20	0.98**	3.89 **
Error	150	0.32	0.41
C.V.%		0.84	5.72

** Significant at $P \leq 0.01$

Table 2. Total milling yield and grain breakage as affected by growing period. Means are averaged over five varieties and six harvest times

Growing period	Total milling yield (%)	Grain breakage (%)
1989	66.24 a	9.59 a
1990	67.81 b	12.77 b

Means of each column followed by different letter indicate significant differences at $P \leq 0.01$.

Table 3. Total milling yield and grain breakage of five rice varieties. Means are averaged over six harvest times

Variety	Total milling yield (%)	Grain breakage (%)
Ispaniki A	69.96 a	11.96 b
Evropi	69.24 b	9.32 d
Strymonas	68.41 c	9.08 d
Axios	64.55 d	15.72 a
Roxani	62.99 e	9.78 c

Means of each column followed by the same letter in the same column are not significantly different at $P \leq 0.01$.

Table 4. Total milling yield and grain breakage at six different harvest times. Means are averaged over five varieties

Harvest time	Grain moisture content (%)	Total milling yield (%)	Grain breakage (%)
1st	22.16	65.71 e	6.53 d
2nd	20.38	67.60 b	7.22 e
3rd	17.92	68.60 a	9.28 d
4th	16.08	67.57 b	11.86 c
5th	15.17	66.54 c	14.36 b
6th	13.89	66.11 d	17.83 a

Means of each column followed by the same letter in the same column are not significantly different at $P \leq 0.01$

Figure 2.1: The Breakage of Rice on Different Moisture

Besides higher debranning/polishing duration results in more cracks, even at low milling chamber and initial grain temperature. Lower milling chamber and initial grain temperatures improves milling quality by reducing stress cracks, as compared to higher temperature conditions. As the polishing duration increases, there is increase in degree of milling (DOM), as well as the heat generation in the grain so does the heat stress. With the increase in grain temperature and milling chamber temperature, this problem aggravates, resulting in higher broken content. Low milling chamber temperature improves the performance of the machine and milling quality of grain even in abrasion whiteners.

Table 1 The real and coded form of the process variables and the responses for varying environmental milling

No. of runs	Milling chamber temperature		Initial grain temperature		Milling duration		Degree of milling (DOM), %	Broken content, %	Specific energy consumption, kJ/%DOM
	Real value, °C (x_1)	Coded value X_1	Real value, °C (x_2)	Coded value X_2	Real value, s (x_3)	Coded value X_3			
1	11	−1	15	0	120	−1	7.81	6.30	9.75
2	25	1	15	0	120	−1	8.67	7.75	8.78
3	18	0	15	0	150	0	8.75	5.94	10.88
4	18	0	15	0	150	0	8.72	5.88	12.12
5	25	1	15	0	180	1	10.23	9.88	11.16
6	18	0	15	0	150	0	8.65	5.67	13.23
7	18	0	15	0	150	0	8.61	5.70	13.20
8	25	1	25	1	150	0	10.02	11.25	9.50
9	11	−1	5	−1	150	0	7.68	3.02	12.39
10	18	0	25	1	180	1	10.58	11.67	10.79
11	11	−1	25	1	150	0	9.08	10.25	10.48
12	25	1	5	−1	150	0	8.58	7.14	11.09
13	18	0	15	0	150	0	8.66	5.70	13.03
14	11	−1	15	0	180	1	9.64	8.52	11.85
15	18	0	5	−1	180	1	8.94	3.94	12.78
16	18	0	25	1	120	−1	8.51	7.30	8.95
17	18	0	5	−1	120	−1	7.43	2.77	10.25

Figure 2.2: Broken Rice Content in Different Temperature

By developing a prototype of this system, user can determine the percentage of broken rice that yielded. This prototype will use imaging method by using scanner as tools of prototype to take the picture of rice yielded and then process the image to get the result. This method will focus on the size of rice that being scanned. This prototype will only focus on one type of rice which is "Long Grain Rice" and the sample taken is "Beras Jati". The long Grain rice size is approximately 7mm in length and 2 mm width [14]. Size of 6-7mm is considered normal long grain rice, and lower than 6mm is considered broken rice. By using this size reference, the percentage of broken rice can be determine by calculate the numbers of normal rice and the number of broken rice and then comparing the result by using percentage formula.

2.2 Studies on Existing Systems

There are several systems that use the image analysis to get the result and comparing the final result with the conventional or manual method. For example, the research of Department of Food Science and Technology, Institut of Agropysics that develops a system to monitoring geometric characteristics of rice during processing by image analysis system and micrometer measurement.

The method used is images were prepared using a desktop scanner (Canonscan 8400F). Fifty rice kernels were placed on the glass plate of the scanner avoiding kernel to kernel contact. The kernels were then covered by a non-reflecting black cloth. The scanner resolution was set to 300 dpi and the images were stored in JPEG format for further analysis. The Clemex image processing software (Clemex Vision Professional, PE4, Canada) was used to determine the required measurements of each grain. The images were processed with a 5×5 filter to reduce noise. Different threshold levels were selected for each rice variety at each processing level. By removing the background of each image, the images only contained the grains. Further image analysis determined the area, sphericity and also major and minor axes representing the length and the width of grains, respectively. The determined parameters were in pixels and the program had the capability to convert the measurements to μm.

The result get from the research is the size of kernel at all the levels of processing (rough rice, brown rice, Milled rice) do have some difference in size but not a major difference which only 0.1-1.0 mm difference in Mean and standard deviation. This shows the reliable of image processing toward determining the size of kernel.

The advantage of this system is, it can calculate the Length, width and height of the kernel in different stage of processing. It can show the different size of kernel in each stage. Apart from that it calculates the size of different type of paddy which is Tarom mahalli paddy, Fajr paddy, and Neda paddy. It also can differentiate the color of kernel in each stage of milling .Last but not least is by using the image processing method, the time taken to get the result just take 3 minute compare to the manually done that take almost 1 hour to get the result.

The disadvantage of this system is, it cannot determine the percentage of rice that broke in the process of milling. Beside that it depend on many other software to calculate the size of the kernel. Last but not least is it still take a lot of time to calculate the size of kernel because the lower the time taken to calculate the size of kernel, the higher the reliability of the system.

Second current system used nowadays is the Digital Image analysis Method for Rapid Measurement of Rice Degree of Milling. A digital image analysis method was developed to quickly and accurately measure the degree of milling (DOM) of rice. The digital image analysis method was statistically compared to a chemical analysis method for evaluating DOM, which consisted of measuring the surface lipids concentration (SLC) of milled rice. The surface lipid area percentage (SLAP) obtained by the image analysis method and the SLC obtained by chemical analysis had a high coefficient of determination using a quadratic model (*R*2 = 0.9819) and using a logarithmic model (*R*2 = 0.9703). The quadratic model and the logarithmic model were validated using the test data set and it received high coefficients of determination

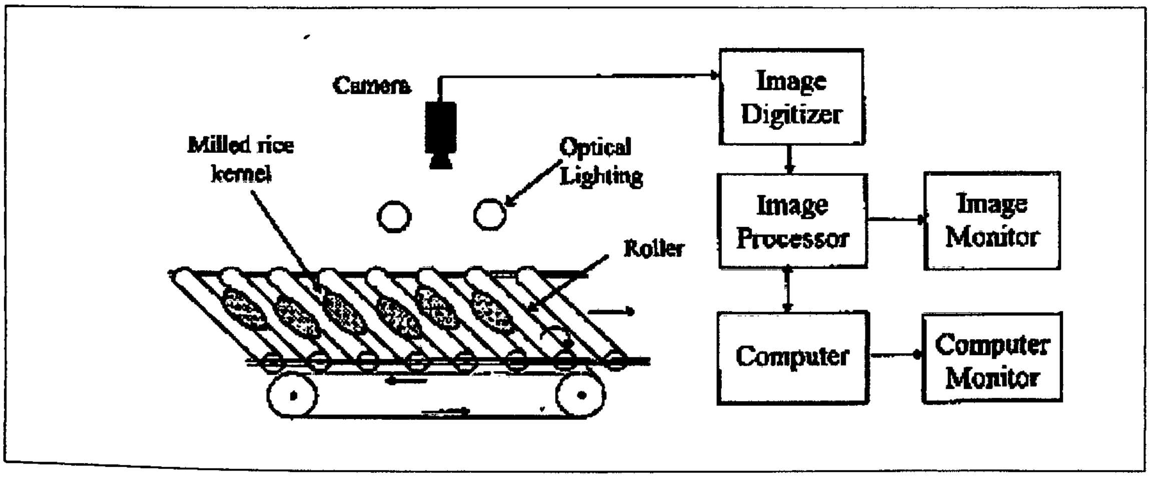

Figure 2.3: Measurement of Rice Degree of Milling

The main objective for this system is to measure the surface lipid concentration (SLC) of the milled Kernel as an indication of Degree of Milling (DOM). The system overview is as follow:

A machine vision system using an area-scan CCD color camera was developed, The color camera, equipped with a 50-mm lens and a 40-mm C-mount lens extension tube, was mounted in an enclosure that housed a fiber optic lighting source and a rice roller conveyer. The camera was set at 101.6 mm (4 in.) above the roller conveyer, and the red channel of the camera was used to capture the images. A fiber optic lighting source (Fiber-lite high-intensity illuminator, model 180, Dolan-Jenner Industries) was used to illuminate the rice kernels. The fiber optic lighting source was set at 101.6 mm (4 in.) apart and 88.6 mm (3.5 in.) above the rice roller conveyer. The roller rotated the rice kernels to enable the camera to view each rice kernel to capture a full surface image.

Two operational modes, manual rotation and motorized automatic scan, were developed for capturing the rice kernel images. Only manual rotation mode was used in this research. To reduce reflection of the ambient light, the internal surface of the enclosure and the surface of the roller were painted flat black. A personal computer with an image digitizer and image processing boards was used to collect the rice kernel images. Under the above configuration of the imaging system, the horizontal resolution of each rice kernel image was 6.998 ′ 10–4 in./pixel (1.775 ′ 10–2 mm/pixel), and the vertical resolution was 1.748 ′ 10–4 in./pixel (4.44 ′ 10–2 mm/pixel).

The result from this research is The small predicted errors indicated the accuracy of both calibration equations. In contrast to the time-consuming solvent extraction procedure, the image analysis method using machine vision can quickly obtain the SLAP value of milled rice. By using the statistical model developed in this study, the SLC value from the solvent extraction procedure was easily and rapidly predicted.

By doing some research on this system, we can see the method that they used to decrease the light reflection by making a black surface of machine. Apart from that they also use manual rotation mode to rotate the kernel so that they can take the overall picture of the kernel. But this is also time consuming.

Another system developed by using Image processing is the classification of lemons and tomatoes by Barganita, Campianas, Brasil[15]. This system will differentiate the size and color of the fruits. The method is by getting images from scanner, other video resources, cameras, FireWire or frame grabber. The system named as "ImageJ software".

The experiment setup done by composing a CCD camera and a PC and no special color sensor were needed because the ImageJ software is able to process the colored image to RGB components percentages. As an example for Classification of lemons by size, a number of six lemons were selected then the picture of the lemon taken by CCD camera which in turn was connected to PC. The software process the image by transformation in 8 bits image. It was eliminated the background so that the determination of size is more accurate.

By doing some research on this system, we can get the method they used which transform the picture by eliminating the background and just take the picture of specimen to be considered. But the disadvantage of the software of the system is, it use so many device. It make the inconsistency in result. Therefore the system should use only one device to make a consistent result.

2.3 Development Tool

MATLAB is a widely used tool in the electrical engineering community. It can be used for simple mathematical manipulations with matrices, for understanding and teaching basic mathematical and engineering concepts, and even for studying and simulating actual power systems and electric systems in general. The original concept of a small and handy tool has evolved to become an engineering workhorse. It is now accepted that MATLAB and its numerous Toolboxes can replace and/or enhance the usage of traditional simulation tools for advanced engineering applications.

2.4 Studies on Devices

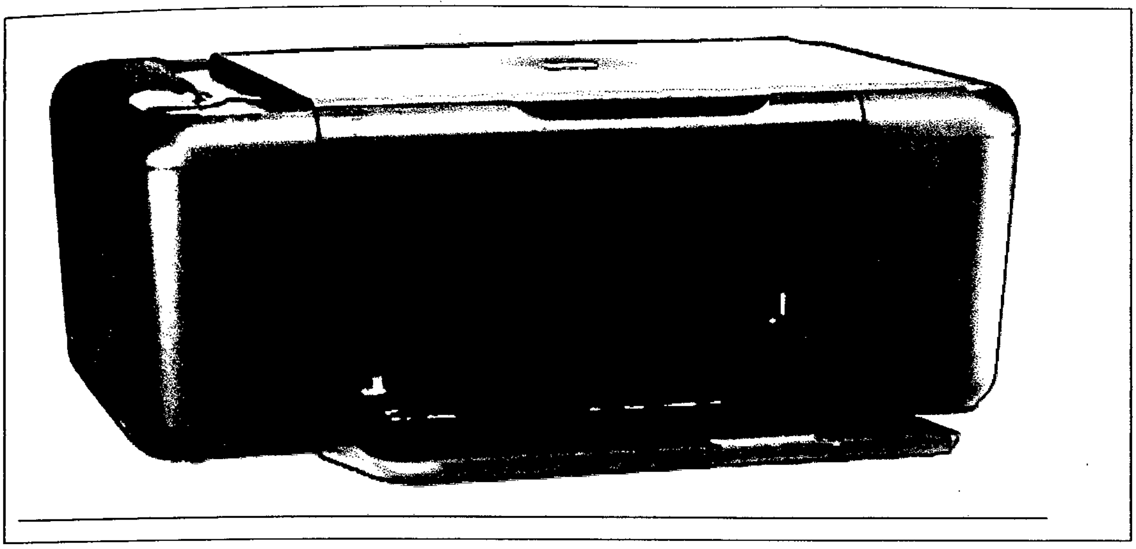

Figure 2.4: Hp F2480 with Scanner

Scanner is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Common examples found in offices are variations of the desktop (or flatbed) scanner where the document is placed on a glass window for scanning.

The device that will be use is hp printer F2480 that equipped with a scanner that can be used to scan the specimen. Hpf2480 scanner can scan the specimen and convert the picture to several file type such as bitmap image, Tiff Image, JPEG image, PNG Image, PCX image, and Flash pix.

Apart from format, the hpf2480 scanner also can convert the picture to three output color which is color, grayscale and white and black. For this system prototype, we will use white and black color. This is because, the measurement will be easy with only two colors considered and it will enhance the accurateness of the system.

Last but not least is hpf2480 scanner also providing multiple scan resolution to enhance the quality of scanned picture. There are 75ppi, 100ppi, 150ppi, 200ppi, 300ppi, 600ppi, 1200ppi, 2400ppi, and 4800ppi output resolution. This will enhance the accurateness of the picture taken by scanning the specimen.