UNIVERSITI PUTRA MALAYSIA

DETERMINATION OF BROKEN RICE PERCENTAGE USING IMAGE PROCESSING TECHNIQUE

SITI SHARIFAH BIBI BT HANIBAH

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By

SITI SHARIFAH BIBI BT HANIBAH

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the requirements for the Degree of Master Of Science

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Dedicated to my parents,

Hanibah Bin Abu Bakar and Faridah Bibi Binti Syed Mohamed

Hj. Abu Backer Sithik and Hajah Rahmath Nisha

My beloved husband,

Mohamed Nasser Bin Abu Backer Sithik

My beloved son,

Najmi Siddiq Bin Mohamed Nasser

and

friends

with love.

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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Oktober 2014

Chairman : Associate Professor Dr Siti Khairunniza Bejo, PhD

Faculty : Engineering

Physical rice grain composition is one of the components used for rice grading which involve the identification of head rice and broken rice. Rice grading is important to ensure only edible rice reaches the consumer standard. It also protects consumers from price manipulation. In this study, a new approach of image processing technique has been developed to detect and identify head and broken rice based on its physical properties i.e. area, perimeter, minor axis length and major axis length. The rice images were first segmented automatically from its background by using three different image segmentation methods, namely Mean Iterative, Median Iterative and Otsu's method. The Otsu's method provides satisfactory results. It only needs four iterations to complete the process of detection and identification, meanwhile Mean Iterative and Median Iterative takes 11 and 12 iterations, respectively. Furthermore, Otsu's method takes the average of four seconds to run the experiment, meanwhile Mean Iterative and Median Iterative takes average of 10 seconds to complete the experiment. Connected component analysis was later being applied to eliminate unwanted noise.

Results from the statistical analysis have shown that area and perimeter give significant correlations with all of the other properties. However, area gives more consistent result with the value of correlation greater than 0.6 in all properties. Therefore, an area was later used as input parameter in developing a simple model of head and broken rice identification using a linear regression analysis. The model give promising results when tested with 0%,1%,5%,10%,15% and 20% of broken rice taken from 600 samples of rice images with the average percentage accuracy of 98%. Graphical User Interface (GUI) software was developed via MATLAB R2014a to help user directly access the percentage of broken rice from an image.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENENTUAN BERAS PATAH DENGAN MENGGUNAKAN KAEDAH PEMPROSESAN IMEJ

Oleh

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Fizikal bijirin beras adalah salah satu komponen yang digunakan untuk penggredan beras yang melibatkan pengenalpastian beras penuh dan beras patah.Penggredan beras adalah penting untuk memastikan hanya beras yang sudah diproses sampai ke pengguna.Ia juga melindungi pengguna daripada manipulasi harga. Dalam kajian ini, satu pendekatan baru dalam teknik pemprosesan imej telah dijalankan untuk mengesan dan mengenal pasti beras penuh dan beras patah berdasarkan sifat-sifat fizikal iaitu luas permukaan, perimeter, panjang paksi kecil dan panjang paksi utama. Imej-imej beras mula diasingkan secara automatik dari latar belakang dengan menggunakan tiga kaedahsegmentasi imej, iaitu Min lelaran, Median lelaran dan Otsu lelaran. Daripada ketiga-tiga kaedah yang dijalankan Otsu lelaran memberikan hasil yang paling memuaskan. Ia hanya perlu empat lelaran untuk melengkapkan proses pengesanan dan pengenalan, sementara itu kaedah Min lelaran dan Median lelaran masing-masing mengambil masa 11 dan 12 lelaran.

Tambahan pula, lelaran Otsu memerlukanmasa purata empat saatuntuk melengkapkan eksperimen, sementara itu lelaran Min dan lelaranMedian mengambil masa purata 10 saat

untuk menyelesaikan eksperimen. Analisis 'Connected Component'kemudiannya diaplikasikan untuk menghapuskan hingar yang tidak dikehendaki. Hasil daripada analisis statistik menunjukkan luas permukaan dan perimeter memberikan korelasi yang signifikan dengan semua sifat-sifat lain. Walau bagaimanapun, luas permukaaan memberikan hasil yang lebih konsisten dengan nilai korelasi lebih besar daripada 0.6. Oleh itu, luaspermukaan digunakan sebagai input parameter bagi membangunkan satu model untuk mengenalpasti beras penuh dan beras patah dengan menggunakan analisis regresi linear. Model ini memberi keputusan yang memuaskan apabila diuji dengan 0%, 1%, 5%, 10%, 15% dan 20% kandungan beras patah diambil dari 600 sampel imej beras dengan peratusan ketepatan purata 98%. Perisian Pengguna Grafik (GUI) telah dibangunkan melalui MATLAB R2014a untuk membantu pengguna mengakses secara langsung peratusan beras patah dari imej.

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I certify that a Thesis Examination Committee has met on 28 April 2008 to conduct the final examination of Siti Sharifah Bibi Bt Hanibah on her thesis entitled " Broken Rice Determination with the Aid of an Image Processing Technique" in accordance with The Universities and Universities Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia[P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Masters of Science.

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DECLARATION

I declared that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

SITI SHARIFAH BIBI HANIBAH

Date:

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CHAPTER 1

INTRODUCTION

1.1 Background

Rice (OryzaSativa) is the most important staple food for a large part of human population, especially in Southeast Asia such as Malaysia and Indonesia. There are several steps involved in rice processing from paddy to white rice. Hulling is the process of removing husk from paddy. This is achieved by the moderate action of rubber rolls applied to the paddy, after which the husk aspirator splits the husk from the rice by means of air aspiration. The brown rice then passes into the paddy separator, which splits any unhulled kernels from the brown rice and reutilizes them into the huller. During whitening and polishing, bran layers are removed from the brown rice. This not only improves the appearance of the rice but also increases its shelf life, since the lipids contained in the embryo and the bran layers are highly susceptible to enzymatic and non-enzymatic oxidation. The bran removal is best achieved in several steps to ensure evenly milled rice grains with minimum broken and optimum uniformity. The whitened rice is then polished to give it a varnish to silkiness. Grading is the process of eliminating the broken from head rice and categorize them into well-defined fractions of different length. Optical inspection is the final quality control and enhancement step in the rice mill. Discoloured grains and optionally chalky kernels are removed to yield a first grade product. To achieve a constant and reliable quality in packed white rice, various white rice fractions are blended according to the market necessity and trade standards. The marketable white rice is packed and sent out to the customers either locally or for export.

There are several factors involved in rice grading such as dead rice, damaged and brewers percentages, defectives, foreign matter, presence of paddy, whiteness, chalkiness and moisture content. In general, there are two types of grading systems in Malaysia i.e. paddy grading and rice grading.

Paddy grading systems used by millers while rice grading systems used by both millers and wholesalers. Paddy grading system is a guideline for weight deduction schedule consists of four major parts, namely moisture content, damaged grain, immature grain and foreign matters. Paddy and rice is considered dry when its moisture content is 14% or below. Paddy and rice gains or losses water based on its moisture and the humidity of surrounding air. If the humidity is low, high moisture rice will lose water until it comes to constants and if the humidity is high, low moisture rice will gain moisture. Grains with high moisture content are too indulgent to withstand hulling pressure without undue breakage and may be pulverized. Grain that is too dry becomes brittle and has greater breakage. This relationship is affected by temperature as well.

Damaged grain occurs when paddy changes from its usual color, to rotten, moldy or germinated. These types of destruction are caused by water, insects, and heat exposure. Yellowing is caused by over-exposure of paddy to drizzling environmental conditions before it is dried. This results in a combination of microbiological and chemical activity that overheats the grain similar to a milled form of parboiling. These fermented grains often possess partly gelatinized starch cells and generally resist the pressures applied during grain milling. While the presence of fermented grain does not affect milling yields it does relegate the quality of the milled rice because of the unappealing presence.

The existence of black spots around the germ end of the brown rice kernel is affected by the microorganisms and is increased by opposed weather conditions. In the process of milling, these black spots are only partly detached which accordingly increases the presence of damaged grains.

Immature grain is the paddy which is not ripe enough. The quantity of immature paddy grains in a sample has a major influence on head rice yield and quality. The immature rice kernels are very slender and chalky and this results in unnecessary production of bran, broken grains and brewer rice. The optimal phase to harvest grain is at about 20-24% grain moisture or about 30 days after flowering. If the harvesting time is too late, many grains are gone through shattering or dry out and are cracked during threshing, which causes grain breakage during milling.

Foreign matters are anything that cannot turn into rice. These include stalks, dirt, mud or sand. Mixtures of varieties cause difficulties at milling and usually result in reduced capacity, excessive breakage, lower milled rice recovery and reduced rice. Different sizes and shaped grains make it more difficult to adjust the hullers and polishers to crop whole grains. This result in low initial de-hulling efficiencies, a higher percentage of recirculate paddy, non-uniform whitening, and lower rate of milled rice.

The grades of the rice are discriminated by the grain length, namely long grain (A1-A4) for grain length not less than 6.2mm, medium grain (B1-B4) for grain length more than 5.2mm but less than 6.2mm and short grain (C1-C3) for grain length less than 5.2mm. Others grades are categorized as follows; broken rice (D1-D2), glutinous rice (E1-E2) and (F) for parboiled rice. The rice grading systems presently used in Malaysia is classified into eight grades. There is only one grade for glutinous rice, which contain not less than 80% of glutinous rice and not less than 60% of head rice is graded as glutinous rice. Parboiled rice is essentially white rice that has been soaked, steamed, dried and milled.

Rice processed this way contained less than 80% of head is graded as parboiled rice. Other white rice is divided into graded rice and broken rice.

In Malaysia, graded rice is classified into three grades namely standard, premium and super. Standard is refers to rice with high broken content (up to 45%) and may contain 100% damaged grain. Premium is refers to rice with high broken content (up to 45%) but its damaged grain should not exceed 2%. Super is further divided into three different grades based on its broken content, namely Super Tempatan 15% (contain about 15% broken rice), Super SpesialTempatan 10% (contain about 10% broken rice) and Super SpesialTempatan 5% (contain about 5% broken rice).

Based on the International Rice Research Institute (IRRI) grain breakage is a result of fissuring, or the development of cracks in the endosperm prior to milling. To a certain extent, fissuring in rice grain arises naturally in the field due regular changes in temperature and relative humidity. More importantly, fissuring can be caused by inadequate management of grain at all post-harvest operations from harvesting through to milling. Improper drying techniques frequently lead to fissuring in grain, or rewetting of stored paddy, and improper milling techniques. Finally, not all fissured grain will break during milling, and medium or long grain varieties are more prone to breakage than short grain variations. Grain composition is one of the components used for rice grading. It refers to head rice and broken rice. Head rice consists of whole kernel or at least 8 part of kernel, meanwhile broken rice consist of less than 8 part of kernel. Fig. 1 shows the diagram of head and broken rice graded by Padiberas NasionalBerhad (BERNAS).

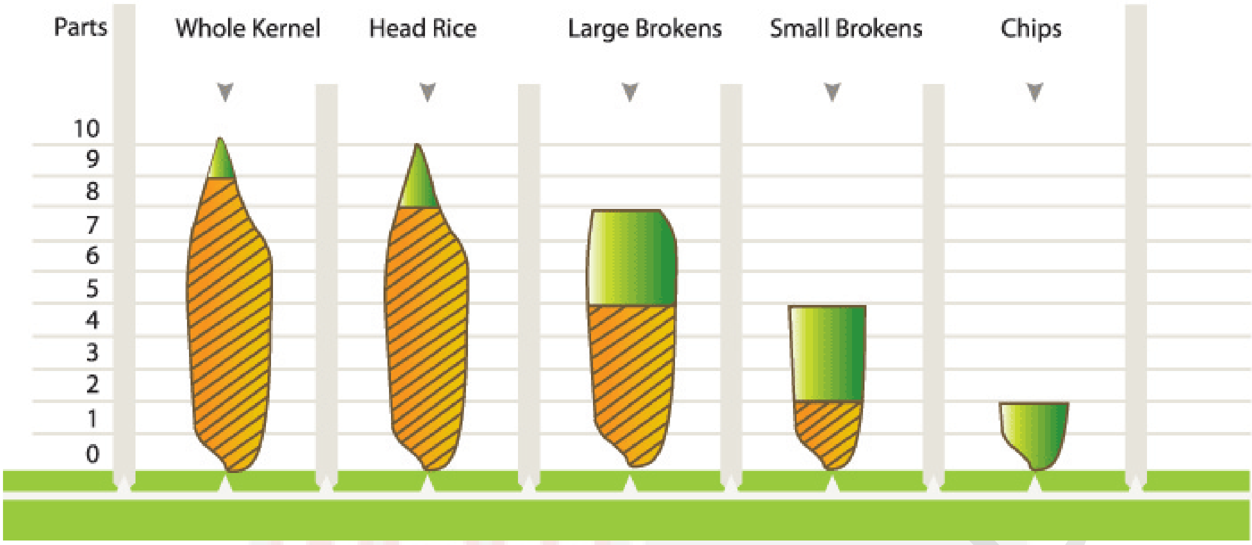

Figure 1: Rice grain composition

1.2 Problem statement

According to Bernas Assistant Senior Manager, Abdul Razak Abdullah, only 81% of the paddy sent to the factories from the fields were viable, the rest might be destroyed grains that were prone to breakage during cooking, while immature grains can be result in powdery and chewy rice. Today, more consumers are discerning on the type of rice they wish to consume, contributing to the demand of higher quality local rice.

Based on the local newspaper, the quality of local rice is under suspicion with regard to the amount of broken rice in the desired grade (NewStraitsTimes, 26 Jan 2011). This condition might happen because some of the rice millers and rice wholesalers are trying to cheat the customers by selling lower price of rice using the higher price (myMetro, 26 Jan 2011). In normal practice the rice is mixed according to the desired grade during a milling process using a machine. Therefore customers don’t have any appropriate knowledge and tools to determine the quality of rice.

Presently, the white rice is divided into head rice, large and small broken rice by a sifter. The sifter is made up of a series of oscillating screens through which the rice passes. The output from the bottom screen is the exact broken tips and is called the brewers. To attain a higher degree of precision for grading and separation, a length or indent grader is also used. The broken and smaller rice pieces fall into the indents on the rotating roller apparent and are removed leaving the whole rice kernels or head rice. Different indent sizes are used according to the size of the grain. Broken rice are produced as a result of milling process. Consumers prefer as few broken rice kernel as possible and this may also one of the factor influencing the price of rice. Furthermore, a grain of broken rice gives a low fibre texture and low nutrient level.

Today's image processing methods has become an alternative way in estimating rice quality. The market of high worth rice with a low percentage of broken grains which is less than 10% is dominated by Thailand, Vietnam and the United States growers whose production essentially meets the market anxieties of developed countries. The market of lower quality rice which is more than 10% of broken kernels is conquered by exporters from Asia region mainly Thailand, Vietnam and India. Medium quality rice included 15 to 20% broken content while low quality rice included 25 to 35% broken up to 100% broken. This research presents a new approach of image processing technique to identify the shape of the rice and its properties. These properties will be used to develop a new algorithm for head and broken rice identification and quantification suitable for rice grading and quality measurement.

1.3 Objectives

The general objective of this study is to used image processing technique to detect and identify head and broken rice based on its physical properties.

This study embarks on the following specific objectives:

1. To identify suitable image segmentation techniques for broken rice detection
2. To determine suitable image features for broken rice detection
3. To develop a technique of broken rice detection by using image processing approach

1.4 Scope of the study

In this study, the MR 219 rice variety was used. MR 219 is a Malaysian Indica rice variety resulted from a cross between MR 137 and MR 151, which was released by the Malaysian Agricultural Research and Development Institute (MARDI), in 2001. The variety is considered a high yielding rice with a suitable quality in shape and taste. The MR 219 is widely cultivated in Malaysia and is the most common rice used by consumers.

1.4 Thesis outlines

- Chapter one introduces the subject of the research and the objectives of the thesis.

- Chapter two discusses rice grading system in Malaysia and available image processing techniques for broken rice detection. Summary of the literature review was mentioned in the chapter.

- Chapter three explains the methodology of the research from preparation until the last part of the finding for broken rice detection. Details of the rice image acquisition, suitable thresholding method identification, suitable feature identification and development of broken rice detection algorithmare elaborated further.

- Chapter four presented the results on the three thresholding segmentation methods namely mean iterative, median iterative and Otsu iterative. Along with precisely discussed the best of the operating parameters to be used for broken rice detection algorithm development. The chapter also compared the image processing model with the current existing machine.

- Chapter five concludes by giving the optimum parameters and methodsfor broken rice detection Finally, recommendations for future work to improve this research are also included.

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