UNIVERSITI PUTRA MALAYSIA

IDENTIFICATION OF DORSAL AND VERTICAL SURFACE OF RUBBER SEEDS USING IMAGE PROCESSING APPROACH

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By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master Sciences

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June 2017

Chairman: Associate Professor Siti Khairunniza Binti Bejo, PhD
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Natural rubber tree or known as *Hevea brasiliensis* is an important economic resource for the world and one of major plantation crops in Malaysia. To increase rubber production, planting method of rubber seeds must be improvised. Proper placement of seeds are important in order to increase the germination rate of rubber seeds. Rubber has two different surfaces which are dorsal and vertical. There are numerous darker mottles on the dorsal surface whereas only a straight valley at the centre of vertical surface. Vertical surface needs to be placed downward, attaching to the soil and dorsal surface needs to be placed on the top, facing to the sky. Current method of planting rubber seed is by growing the seedlings in a nursery. It needs many labors to plant the seeds one by one in a polybags. This caused high cost of production due to high labor intensity. To reduce the labor intensity and improving the production efficiency, it is necessary to use an automatic detection technology. This study was conducted to identify the dorsal and vertical surface of rubber seeds using image processing approach. There were 1600 images of dorsal and vertical surfaces at different positions acquired using SM-P605 of Samsung Galaxy Tab in RGB color format. Significant difference between dorsal and vertical surface can be seen clearly at the center of the seed. In this study, horizontal position of the rubber seed image was used as the reference. Therefore, after underwent all the image pre-processing steps, the orientation of the seed was identified. The seed was rotated into horizontal position based on the identified orientation. Then, canny edge detection was used to extract the important edge at the center of the seed in the horizontal based. From the center edge region, five features were extracted i.e. maximum length of *x*-axis, ratio of *y*-axis to *x*-axis, number of pixels inside edge region, maximum convolution and number of intersections. These features were used to develop a new prediction model using conditional statement method in identifying dorsal and vertical surface. Besides prediction model, support vector machine (SVM) and artificial neural network (ANN) were also used to classify dorsal and vertical surface. The result had shown that all

the samples were successfully rotated into the horizontal positions with an average of error of 0.52%. The developed prediction model gave the most accurate result with 88.75% accuracy as compared to ANN (82.61%) and SVM (72.25%).

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

MENGENAL PASTI PERMUKAAN DORSAL DAN VERTIKAL PADA BENIH GETAH MENGGUNAKAN PENDEKATAN PEMPROSESAN IMEJ

Oleh

SITI NURUL AFIAH BINTI MOHD JOHARI

Jun 2017

Pengerusi: Professor Madya Siti Khairunniza Binti Bejo, PhD
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Pokok getah asli atau dikenali sebagai Hevea brasiliensis adalah sumber ekonomi yang penting bagi dunia, dan salah satu tanaman perladangan utama di Malaysia. Untuk meningkatkan pengeluaran getah, kaedah penanaman benih getah perlu diubahsuai. Penanaman yang betul benih adalah penting untuk meningkatkan kadar percambahan benih getah. Getah mempunyai dua permukaan yang berbeza iaitu dorsal dan vertical. Terdapat banyak muncung gelap di permukaan dorsal manakala hanya lembah lurus di tengah permukaan vertical. Permukaan vertical benih getah perlu diletakkan ke bawah, menghadap pada tanah dan permukaan dorsal perlu diletakkan di atas, menghadap ke langit. Kaedah semasa bagi penanaman benih getah adalah dengan menanam benih di tapak semaian. Ia memerlukan ramai pekerja untuk menanam satu per satu benih di dalam polibeg. Ini menyebabkan kos yang tinggi kerana intensiti buruh yang tinggi. Untuk mengurangkan intensiti tenaga kerja dan meningkatkan kecekapan pengeluaran, adalah perlu untuk menggunakan teknologi pengesanan automatik. Kajian ini dijalankan untuk mengenal pasti permukaan dorsal dan vertical benih getah menggunakan pendekatan pemprosesan imej. Terdapat 1600 imej permukaan dorsal dan vertical di kedudukan yang berbeza diperolehi menggunakan *SM-P605 Samsung Galaxy Tab* dalam format warna RGB. Perbezaan yang signifikan di antara permukaan dorsal dan vertical dapat dilihat dengan jelas di tengah-tengah biji benih. Dalam kajian ini, kedudukan mendatar oleh imej biji getah tersebut telah digunakan sebagai rujukan. Oleh itu, selepas menjalani semua langkah pra-pemprosesan imej, orientasi benih itu telah dikenalpasti dan benih telah diputarkan ke kedudukan mendatar. Selepas itu, pengesanan *canny* telah digunakan untuk mendapatkan ciri-ciri yang penting di tengah-tengah benih berasaskan kedudukan mendatar. Daripada pinggir pusat biji benih, lima ciri-ciri ini telah diekstrak iaitu panjang maksimum *x*-paksi, nisbah paksi-*y* kepada paksi-*x*, bilangan piksel di pinggir pusat, kekusutan maksimum dan bilangan persimpangan. Ciri-ciri ini telah digunakan untuk membangunkan model ramalan baru dengan menggunakan kaedah penyataan bersyarat dalam mengenal pasti

permukaan dorsal dan vertical. Selain model ramalan, mesin sokongan vektor (SVM) dan rangkaian neural tiruan (ANN) juga telah digunakan bagi mengkelaskan permukaan dorsal dan vertical. Keputusan telah menunjukkan bahawa semua sampel telah berjaya diputar ke kedudukan mendatar dengan hanya 0.52% ralat purata. Model ramalan memberikan hasil yang paling tepat dengan 88.75% ketepatan berbanding ANN (82.61%) dan SVM (72.25%).

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I certify that a Thesis Examination Committee has met on 2 June 2017 to conduct the final examination of Siti Nurul Afiah bt Mohd Johari on her thesis entitled "Identification of Dorsal and Vertical Surface of Rubber Seeds using Image Processing Approach" in accordance with the Universities and University 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 Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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CHAPTER 1

INTRODUCTION

1.1 General overview

Natural rubber tree (*Hevea brasiliensis)* is an important economic resource in the world and one of the major plantation crops in Malaysia. It is a tropical crop originated from the Amazon in South America and can grow up to 18 to 39 meters height. It grows best in warm and moist climate. Malaysia is a leading producer with the largest exportation of natural rubber. The main destination for Malaysia's natural rubber exports are China, Germany, United States, Iran, Brazil, Portugal, South Korea, Turkey and Finland. According to Malaysia Rubber Board (2016), total production of natural rubber in 2015 was 722,122 tonnes. However the production of natural rubber was dropped in 2016 with 187,690 tonnes. The production of dry natural rubber was decreased constantly from year 2011 until 2014 but increased slightly in year 2015. Yet, it was decreased drastically in year 2016. The production of latex was also decreased from year 2006 until 2016 as shown in Figure 1. The main reason was due to the loss of rubber estates which has been transformed into real estate development or palm plantation that bring more stable and sustainable returns.

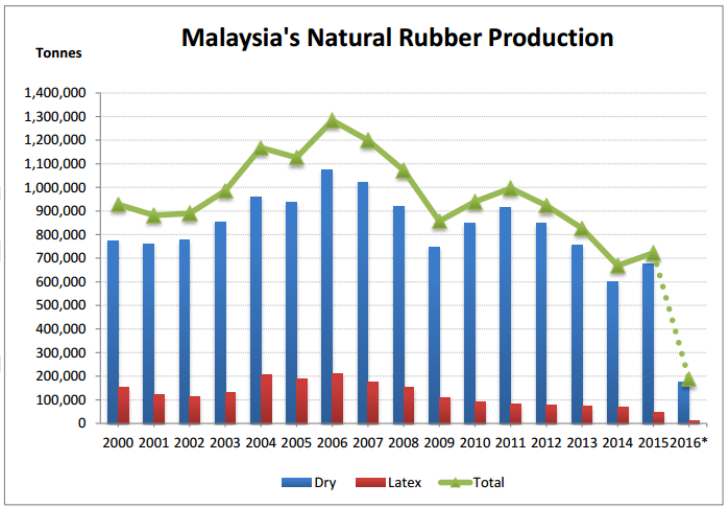

Figure 1: Graph of Malaysia's Natural Rubber Production – 2006 to 2016
(Malaysia Rubber Board, 2016)

Rubber tree is well known for its latex and timber productions. Rubber wood has been used for furniture making (Malaysia Rubber Board, 2009). Rubber tree starts to bear fruits at four years of age. Each fruit contain three to four seeds which fall to the ground when the fruits ripens and splits. In general, each tree produce 800 seeds (1.3kg) twice a year. The annual production of rubber seeds in Malaysia is 1.2 million metric tons based on the estimated average of 1000 kg seeds per ha per year. Cultivation in nursery is one of the method that can produce high quality of rubber seedling, which thus can increase the rubber production.

Nursery is the place where plant is propagated and grown to usable size. Nursery is required for raising seedlings, budded stumps and budwood. The purpose of rubber seedling in nursery is to increase the rate of rubber young budding which is at least 90 percent growing.

Detail process of rubber planting in nursery is shown in Figure 2. To ensure the seed is planted in proper way, its vertical surface must attach downward facing to the soil. If the seed has no germination or poor seedling, it will be rejected. Meanwhile, healthy seedling of rubber will be selected and ready for budding for 4 to 5 months. Finally, after 9 to 10 months in budding process, it will be transferred for field planting. This approach really helps to increase the production of rubber, at the same time, increasing the income level of rural communities in the state.

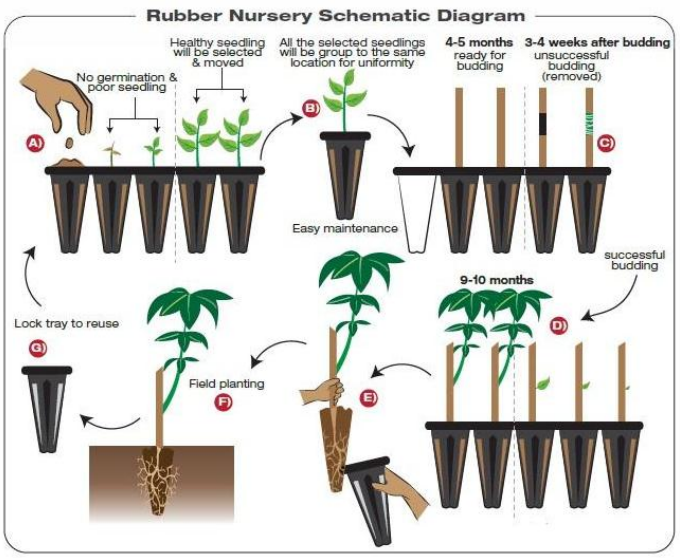

Figure 2: Rubber Nursery Schematic Diagram (G-Planter Malaysia, 2016)

In this modern era, the image processing techniques has been proven to be an effective tools for analysis in various field and application especially in agricultural sectors. Image processing in agriculture and food industries has been applied in the areas of sorting, grading, detection of defects, and selection of good products based on the colour, shape and texture.

1.2 Problem statement and motivation

Rubber seed is considered to be uncooperative in nature as it easily lose viability very rapidly in the field (Robert, 1984). Therefore, the seeds are picked up daily and transported to the nursery for germination. There are two different surfaces of rubber seeds which are dorsal and vertical (Figure 3).

Figure 3: Rubber seed surfaces

They need to be planted in proper way where the dorsal surface is facing upward and vertical surface is facing downward attached to the soil. Failing doing that will decrease germination rate and can cause high loss. This process of planting was done manually by labourers. In order to reduce the labour intensity and improving the production efficiency, it is necessary to use an automated system. Recent evolution of image processing techniques in agricultural field shows high potential on its possibility to overcome this issue.

1.3 Research objectives

The main objective of this research is to identify dorsal and vertical surface of rubber seed using an image processing technique. The method was developed based on its suitability to be used in developing an automated rubber seeds planting system for nursery application. Specific aim of the research are;

1. To extract appropriate features i.e maximum length of *x*-axis, ratio of *y*-axis to *x*-axis, number of pixels inside edge region, maximum convolution and number of intersections for the identification of dorsal and vertical surface of rubber seeds using image processing technique.
2. To detect dorsal and vertical surface of rubber seeds in various positions at different orientation i.e 0˚, 22.5 ˚, 45˚,67.5˚, 270˚, 292.5˚, 315˚, 337.5˚ using image processing technique.

3. To create a new prediction model for the identification of dorsal and vertical surface using conditional statement method.
4. To compare the performances of classification of dorsal and vertical surface between new developed prediction model, Support Vector Machine (SVM) and Artificial Neural Network (ANN).

1.4 Scope and limitations

This research was only focused on detecting features for dorsal and vertical surface of fresh rubber seeds in various orientations. The seed was experimentally arranged one by one and not randomly placed when image was taken. The seed image was acquired in horizontal based (original position). It was then rotated into 8 different orientations i.e. 0˚, 22.5 ˚, 45˚,67.5˚, 270˚, 292.5˚, 315˚, 337.5˚. The images of these rubber seeds were taken using a camera under controlled environment at Spatial Lab, Faculty of Engineering, UPM with fixed setting and constant lighting intensity.

1.5 Thesis outline

This thesis consists of five chapters i.e. Chapter One, Chapter Two, Chapter Three, Chapter Four and Chapter Five. Chapter One presents an introduction, problem statements, objectives and scope and limitation of the research study. Chapter Two consists of literature review about rubber seed and image processing that include image segmentation, edge detection, features identification, and application of image processing for seed detection. Methodology of the research study will be described briefly in Chapter Three, i.e. sample preparation, image pre-processing, seed orientation, edge detection, features analysis, and model prediction. Chapter Four presents about the results and discussions of the performance based on the proposed method. The last chapter which is Chapter Five concludes all the research study and discuss some suggestions for future study.

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