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IMPROVING OIL PALM FRESH FRUIT BUNCH GRADING SYSTEM VIA SOFTWARE AND HARDWARE MODIFICATIONS

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By

MUHAMMAD KASHFI BIN SHABDIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

To whom their true love and support were behind my success

To my beloved mother Roliah Binti Ahmad

Father Shabdin Bin Mohd Long

Brother and Sisters

My friends

Thank You for everything

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

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Chairman : Abdul Rashid Mohamed Shariff, PhD
Faculty : Science

An improved technique is proposed on how to increase the quality of oil palm ripeness grading in the Real Time Fresh Fruit Bunch (FFB) Oil Palm Grading System. This technique improvised the existing prototype grading system into a higher level “towards commercialization” grading machine. The improved grading machine changed the hardware design and system. Previously, the grading system used two software platforms which were MATLAB and LabVIEW and this was time consuming problem. This problem is due to the size of the image captured which is 1Gb per image. Therefore, the algorithm was migrated to a standalone software using LabVIEW. In this improved implementation, correctly human graded samples of oil palm bunches were image captured and analyzed for two categories. As a result, two sets of low resolved intensity images are captured by the Charged Coupled Device (CCD) camera. The grading system involves the hardware component which is the CCD camera and the software algorithm that is, the LabVIEW software for imaging purposes. The image analysis uses Artificial Neural Network (ANN) technique which includes training and testing of data. Model for the ANN is created based on the training data which is stored in the software memory. The ANN model is then used in the testing process where the software decides the grade of the oil palm fruit bunch. A significant improvement in the design specifications is made between the prototype and the new grading machine, which include weight measurement, sorting process, grip belting and feeder system. In the new machine, the speed for grading 60 bunches per minute is obtained compared to the existing system which is 10 bunches per minute. The design specification shows that the machine completes this process in one minute 33 seconds.

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

PENAMBAHBAIKAN SISTEM MESIN GRED TANDAN SAWIT SEGAR MELALUI PENGUBAHSUAIAN PERISIAN DAN PERKAKASAN

Oleh

MUHAMMAD KASHFI BIN SHABDIN

Disember 2016

Pengerusi : Abdul Rashid Mohamed Shariff, PhD
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Teknik yang lebih baik dicadangkan di dalam kajian ini iaitu bagaimana untuk meningkatkan kualiti penggredan kematangan kelapa sawit menggunakan sistem mesin masa sebenar gred sawit tandan segar (FFB). Teknik ini diubahsuai dari sistem penggredan yang sedia ada ke dalam mesin penggredan rekaan baru. Mesin penggredan yang lebih baik ini diubah reka bentuk perkakasan luaran dan system dalaman. Sebelum ini, sistem penggredan yang digunakan dua platform perisian iaitu MATLAB dan LabVIEW dan ini membawa masalah dari segi pemprosesan masa. Masalah ini adalah disebabkan oleh saiz gambar yang mencecah 1 Gb bagi tiap-tiap gambar. Oleh itu, algoritma telah diterjemahkan daripada kod asal menggunakan perisian LabVIEW. Dalam kajian ini, sampel sawit digred dengan betul oleh penggred manusia dan imej tandan kelapa sawit yang ditangkap akan dianalisis bagi dua kategori. Dengan ini, dua set imej rendah keamatan ditangkap oleh kamera Peranti Bersama (CCD). Sistem penggredan melibatkan komponen perkakasan kamera CCD dan algoritma perisian yang perisian LabVIEW untuk tujuan pengimejan. Analisis imej menggunakan teknik “Artificial Neural Network” (ANN) termasuk latihan dan ujian data. Model bagi ANN dicipta berdasarkan data latihan yang disimpan dalam ingatan perisian. Model ANN kemudian digunakan dalam proses ujian di mana perisian itu akan menentukan gred tandan buah kelapa sawit. Satu peningkatan yang ketara dalam spesifikasi reka bentuk dibuat antara prototaip dan mesin penggredan baru, termasuk ukuran berat buah sawit, proses penggredan, cengkaman belting dan sistem “feeder”. Dalam mesin baru, kelajuan bagi penggredan 60 tandan seminit diperolehi berbanding dengan sistem yang sedia ada iaitu 10 tandan seminit. Spesifikasi reka bentuk menunjukkan bahawa mesin melengkapkan proses ini dalam satu minit 33 saat.

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I certify that a Thesis Examination Committee has met on _____ to conduct the final examination Muhammad Kashfi bin Shabdin on his thesis entitled "Improving The Oil Palm Fresh Fruit Bunch Grading System via Software and Hardware Modifications" 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 degree of Master of Science.

Members of the Thesis Examination Committee were as follows:

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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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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
API	Application programming interface
BGLAM	Basic Grey Level Aura Matric
CAD	Computer aided design
CCD	Charged Coupled Device
CIE	the International Commission on Illumination
CIELAB	French Commission internationale de l'éclairage, L*a*b*
CMOS	Complementary Metal Oxide Semiconductor
cRIO	compact reconfigurable I/O controller
CVS	computer-vision system
FFA	Free fatty acid
FFB	Fresh Fruit Bunch
FPGA	field – programmable gate array
GigE	Gigabit Ethernet
HSI	Hue, saturation, intensity
ISP	In system programmable
LDR	Light dependent resistor
LED	Light emitting diode
MPOB	Malaysian Palm Oil Board
NI	National Instruments
OS	Operating system
PL	Programming language
RGB	Red, Green, Blue
ROI	Region of interest
RTOP	Real Time Oil Palm
SCM	Single chip microcomputer
SVM	Support vector machine
TPC	Touch panel computer
USB	Universal serial bus
VISI	Virtual Instruments and System Innovation

CHAPTER 1

INTRODUCTION

1.1 Background

Agricultural product assessment by the traditional method was very tedious and time consuming. It was easily biased by the physiological factors, including subjectivity and unreliable evaluation results. Agricultural products play an important role in nearly all food industries quality assessment. While computer technologies were developed and utilized in several research projects around the globe, constructing advanced machines for agricultural product quality assessment by using different methods and approaches improved. This includes constructing new device system which can be integrated. Besides, the process of inspection was divided into two types, namely external grading system and internal quality assessment.

Previous techniques have been active for a long time, however, the techniques are costly, tedious and time consuming added to the lack of accuracy in the system. GarcÍa – Ramos *et al*., (2005) has stated that the previous systems were thought to suffer severely from subjective inferences which lead to inconsistencies. Within this context, high – technology solutions were being pursued machine vision quality grading, well-timed assessment, and precise grading (Malamasa *et al*., 2003). This high–technology is appropriate for both surface and subsurface imaging due to the restricted penetration depth of the interrogating source. Leemans and Destain, (2004); and Njoroge *et al*., (2002) has stated that the automated internal grading solutions have been developing by researchers all around the world. They found that the accuracy in classifying Jonagold apples by using automated internal grading was 73 %. 100 samples were used and 27 % error was calculated and this was because of particular wounds or bruises on the fruit and other defects.

The inspection process for the ripeness quality of agricultural crops is difficult. The problem is to determine the ripeness of huge amount of fruits and vegetable species. Each variety must be assessed according to their specific criteria for the quality determination. The focus is on developing nondestructive methods and processes that can measure quality parameters such as color, thorns and texture. Besides, the system needs to have the capability to predict quality changes under industrial conditions to make reliable proclamations about the shelf life of a product. Therefore, the oil palm grading system is a machine vision system where it detects the ripeness of the fresh fruit bunch (FFB) by using the digital image processing techniques based on external inspection. Subsequently, different methods of digital image processing in this work can be used to classify the oil palm bunch based on the external properties of the fruit.

The grading system is divided into two, which are the external and the internal systems. The external system is based on the external features of the fruit, which are the thorns, texture, color, shape, and size. The internal system, on the other hand, detects the internal features of the fruit, like the quantity of water, acidity, moisture, and damage assessment. This system is an integration of both hardware and software system, which uses certain software for image capturing and image processing. The hardware part consists of a computer, CCD camera, and data acquisition. Currently, there are a number of grading systems that has been developed and used practically to grade and access quality on different types of fruits and vegetables using different techniques of classifying, monitoring, and displaying the fruits. However, these grading systems were unable to justify the requirements of oil palm fruit users based on special parameters and properties of oil palm FFB. Thus, the real time oil palm bunch grading system with specific image processing techniques being develop to work with all the parameters and properties of oil palm FFB. This new system provides an accurate ripeness classification mechanism for oil palm fruit bunch based on all mentioned parameters and properties.

1.2 Problem Statement

In the oil palm ripeness grading today, a grading machine was introduced which was the “Real Time Oil Palm Grading System” by (Alfatni, 2013). This real time machine has been developed to measure the ripeness of the oil palm bunch. It measures three categories of ripeness which are overipe, ripe and underipe. However, in a long run, this machine has limitations. The limitations are in term of both hardware and software systems where integration of hardware and software systems are the most important in fulfilling the main function of the real time grading machine. When image captured are in raw format, the size of the image is too large which is about 1Gb per image, making the integration of MATLAB and LabVIEW become time consuming. To face the limitations, here comes the idea to come up with the second version of the new grading system which would improve the limitations introduced by the previous system. As for all, the new system would increase the accuracy and precision of the system thus upgrade the measuring quality of the trained real time machine.

The system works well for small scale in the lab using LabVIEW software for image capturing while MATLAB software for image processing. However, this two software cause time consuming in the system. Therefore, the scope highlighted here is to migrate the software instead of integrating two software into only one software to do all the jobs. Therefore, an improvement on the system implementation which is the image processing unit is very important. In addition, the software works together with the hardware components in order to implement the mechanical tasks. Thus, the mechanical parts which are the hardware components somehow also need improvement because there are limitations in the current system. These limitations were on the CCD camera used, image filtering, belting design, black box design, push gate design,

pressure pump used, environment illumination, width and height of the conveyor, rusting problem, and addition of feeder and motion sensor.

1.3 Objectives

The objectives of this research are divided into two which first, is to develop a migrate software using LabVIEW environment for detecting oil palm ripeness image capturing and image processing.

The second objective is to improve the image capturing and image processing technique for oil palm ripeness using improved algorithm. After the system algorithm has been identified, the system, however, needs some improvement on both the image capturing and the image processing part.

Therefore, to simplify, there are two main objectives to be achieved in this research;

1. To develop a migrated software system using LabVIEW environment which allows better and efficient image capturing and image processing technique.
2. To enhance and upgrade hardware components to work harmoniously with the new software.

1.4 Scope of Work

The proposed oil palm grading system detects the external features of the fruit to determine the ripeness of the fresh fruit bunch (FFB). Digital image processing plays an important role in detecting and classifying samples without any physical contact.

The proposed software for migrating process is the LabVIEW software which uses data acquisition as its base. Meanwhile, some hardware part is also upgraded to make the system works in parallel. Investigating the existing algorithm is essential because the existing algorithm will become a platform for the new algorithm. By investigating the current algorithm, the working principles of the system can also be understood. In this system, it is significant to know the previously used algorithm because the old system used two software algorithm which works together. By means of studying this algorithm, the methods on how the system works can be upgraded.

1.5 Thesis Layout

This thesis is organized in five chapters. Chapter one comprises of the introduction, which covers the surface of the research problem, objectives, and scope of this study. Chapter two consists of the literature review, which go into detail on the background and other researchers work on the fruit ripeness system. Chapter three outlines the methodology of this study, elaborating the methods carried out to complete the task. Chapter four explains the results of experiments and the new system that have been developing. Finally, the fifth chapter summarizes the research findings, discussions, and suggested potential works for future research.

1.6 Summary

The study revolving in this field has been done by identifying a Real Time Oil Palm grading system where it can function in a real time but with some limitations, therefore further study is carried out. This study suggests improving the Real Time Oil Palm grading system to make it reliable for the agricultural world especially in the field of oil palm plantations.

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