UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical and Electronic Engineering Technology

ESTIMATING THE WEIGHT OF MANGOES USING IMAGE PROCESSING AND ANALYSIS TECHNIQUES

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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ISZUZULDIN AMIRULL BIN MOHD JANUDIN

A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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I declare that this project report entitled “Estimating The Weight of Mangoes Using Image Processing and Analysis Techniques” is the result of my research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

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DEDICATION

I want to thank everyone who has helped me with this thesis. Furthermore, I am grateful to both my parents and siblings for their constant support and encouragement in helping me finish this bachelor's degree project (BDP). I wouldn't have made it this far without them. Apart from that, I'd want to thank all of my fellow lecturers for their guidance, instruction, and mentoring during my studies. Not to mention all of my dear friends I've met along the way. Finally, I'd like to express my gratitude to everyone who has helped me complete this project, whether directly or indirectly.

ABSTRACT

One of the most important factors that consumers associate with mango quality is its size. The weight of the Mango is commonly used to assess its size. This project aims to offer research that uses image processing and analysis techniques to estimate the weight of mangoes. The mango picture produced from the image acquisition system was processed and analyzed using the MATLAB program. There have two methods were used to find the number of pixels of mangoes, which are area and perimeter. This project offers an application that can choose which method is most suitable for the estimated weight of mango based on observations of r-squared values. The relationship between mango pixels and mango weights was examined using linear regression as a statistical approach. As a consequence, methodologies for mango weight assessment using image processing and analysis are practical, viable, and successful.

ABSTRAK

Salah satu faktor terpenting yang dikaitkan pengguna dengan kualiti mangga ialah saiznya. Berat Mangga biasanya digunakan untuk menilai saiznya. Projek ini bertujuan untuk menawarkan penyelidikan yang menggunakan pemprosesan imej dan teknik analisis untuk menganggarkan berat mangga. Gambar mangga yang dihasilkan daripada sistem pemerolehan imej telah diproses dan dianalisis menggunakan program MATLAB. Terdapat dua kaedah yang digunakan untuk mencari bilangan piksel mangga iaitu luas dan perimeter. Projek ini menawarkan aplikasi yang boleh memilih kaedah yang paling sesuai untuk anggaran berat mangga berdasarkan pemerhatian nilai r-kuasa dua. Hubungan antara piksel mangga dan berat mangga telah dikaji menggunakan regresi linear sebagai pendekatan statistik. Akibatnya, metodologi untuk penilaian berat mangga menggunakan pemprosesan dan analisis imej adalah praktikal, berdaya maju dan berjaya.

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δ	-	Voltage angle
t	-	ton
%	-	Percentage
cm	-	Centimeter
mm	-	Millimeter
s	-	Seconds
dB	-	Decibel
T	-	Threshold
ρ	-	Density
v	-	Volume
m	-	Mass
Df	-	Depth factor
g	-	Gram
cm^3	-	Cubic centimeter
r^2	-	Coefficient of Determination
r	-	Correlation Coefficient
L	-	Lenght
W	-	Width
H	-	Height
$\hat{y}$	-	Predicted Value
m	-	Slope
b	-	y-intercept
μ	-	Mean
s	-	Sample Standard deviation
$\sum i$	-	Sum
ϵ	-	Error
ϵ_{rms}	-	Root Mean Square
φ	-	Accuracy

LIST OF ABBREVIATIONS

V	-	Voltage
BDP	-	Bachelor Degree Project
MATLAB	-	Matrix Laboratory
Ts.	-	Technologist
FAMA	-	Federal Agricultural Marketing Authority of Malaysia
USB	-	Universal Serial Bus
JPG	-	Joint Photographic Experts Group
XGA	-	Extended Graphics Array
CCD	-	Charge-coupled device
PL	-	Polarized light
IC	-	Integrated Circuit
BMP	-	Basic Metabolic Panel
IEEE	-	Institute of Electrical and Electronics Engineers
RGB	-	Red, Green, Blue
HSI	-	Hue, Saturation, Intensity
CMYK	-	Cyan, Megenta, Yellow and Black
HSV	-	Hue, Saturation, and Value
YCbCr	-	Luminance and Chroma components
2D	-	2 Dimensional
3D	-	3 Dimensional
MLP	-	Multilayer perceptron
SVM	-	Support Vector Machine
CNN	-	Convolute Neural Network
ANN	-	Artificial Neural Network
RMSE	-	Root Mean Square Error
FPS	-	Frames per second
LED	-	Light Emitting Diode
App	-	Application

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

One of the essential fruits produced in Malaysia, mangoes were valued at 126,000 t in 2002, representing a 12% share of total exports. Post-harvest handling is a crucial step in the fruit production process since it helps maintain its quality. Cleaning, grading, and packing are all part of the post-harvest handling process. Fruit grading is necessary for identifying the quality of the fruit as well as its cost. Many local farmers are still heavily reliant on human labor to grade their fruits, following the grade recommendations set out by the Federal Agricultural Marketing Authority of Malaysia (FAMA). The fruits are assessed according to their size, maturity index, and the presence of exterior flaws (Teoh and Syaifudin, 2007).

Computer vision systems may be utilized for automated fruit inspection and grading and other applications. These systems have been extensively employed in the food and agricultural industries for review and evaluation because they offer an appropriate speedy, economical, consistent, and objective assessment method (Sun, 2000). According to (Kanali et al, 1998) the use of machine vision to automate the inspection of products not only results in labor savings, but it also enhances the objectivity of the inspection process. Advancements have spurred research on constructing a system to assess the quality of various and processed meals in hardware and software for digital image processing and analysis during the last decade. (Gerrard et al. 1996; Locht et al. 1997, 1996).

Image processing and analysis are at the heart of computer vision, allowing it to perform the necessary categorization and measurement tasks (Krutz et al, 2000). (Nagata et al, 1997) The use of image processing and analysis to sort fresh strawberries based on size and shape was examined. The findings revealed that the system could accurately sort 600 strawberries into three classes of condition and five classes of length with 94–98 percent accuracy.

Size is one of the significant parameters that consumer identifies together with the quality of fruits (Aleixos et al, 2002). According to the Florida Agricultural Marketing Association, weight may affect the size of tropical fruits (i.e. Mango, pineapple, watermelon, papaya and starfruit). Manual weighing of fruits to determine their size is time-consuming, labor-intensive, and expensive. Instead of relying on weight to determine fruit size, image processing and analysis methods in computer vision systems may be utilized to make an automated determination of fruit size. The goal of this project was to estimate the weight of the mangoes and estimate the error to assess the ability of the linear model generated in the linear regression analysis to evaluate the importance of the mangoes, which was the primary purpose.

1.2 Problem Statement

The size of the Mango is one of the most critical factors that the customer has identified as being associated with mango grade. According to the Malaysian Federal Agricultural Marketing Authority (FAMA), the size of Mango is defined by its weight. It is, however, difficult to determine the grade of mango fruits because of the difficulty in collecting the fruit at the proper size. Manual weighing of fruits to determine their size is time-consuming, labor-intensive, and expensive.

Furthermore, a computer vision system can automate fruit inspection and grading to achieve the Mango fruit's desired weight. The mango pictures collected from the image capture equipment will be processed and analyzed using the MATLAB program in the computer environment. It is the software's job once image processing and analyzing operations have been completed to determine how many pixels are included inside the mango area of the acquired picture. With the help of the linear regression approach, we will discover a link between mango pixels and mango weights.

1.3 Project Objective

In this study, the primary objectives were to investigate several image processing and analysis methodologies for determining the weight of mangoes, specifically:

a) To develop a vision-based system for mangoes' weight estimation.

b) To select an appropriate feature from the image analysis that can be used as a parameter in the regression technique.

c) To perform testing and analysis in term of the performance of the completed system.

1.4 Scope of Project

In this study, a primitive machine vision system was used to improve mango fruit grading in the country of Malaysia. The methodology is straightforward compared to other state-of-the-art technologies now accessible, but it has limits in analysis and practical use.

a) Image processing and analysis were performed by filtering and thresholding processes using MATLAB software.

b) Image is captured using a digital camera and transferred to MATLAB software.

c) The position of the Mango must remain in a static setting during the capturing process.

d) Just one Mango should be placed at a time.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An overview of estimating the weight of mangoes using image processing and analysis techniques was covered in Chapter 2. This project aims to create image processing and analysis tools to estimate the weight of mangoes, which will assist local producers in classifying the fruits following the FAMA's suggested classification. It was also done in this project to compare and contrast the advantages and disadvantages of past research findings. It discusses the source and supports the claim with facts from similar research or study known as the literature review.

2.2 Image Acquisition and Preprocessing

Image Acquisition and Preprocessing for Machine Vision Systems is a detailed, in-depth guide text covering any element of image acquisition and preprocessing, from scene lighting to image shaping optics, from CCD and CMOS image capture to image transformation

2.2.1 Digital Camera

(Khairul Adilah and Sharifah Lailee, 2016) Indicate that the method of capturing photographs using a digital camera is known as image acquisition. For this experiment, the distance between the camera and the fruit was adjusted at 30 cm. Until being processed into grayscale files, the captured images were saved in RGB color format. According to (Ganiron,