"I hereby declare that I have read through this report entitle "Aerial Monitoring on Mango Using Machine Vision Techniques" and found it has complied the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering"

Signature : .....

Supervisor's Name : Nurbaiti Allah Mohd Ali

Signature : 7/6/2016

AERIAL MONITORING ON MANGO USING MACHINE VISION TECHNIQUES

OH KOK KEN

A report submitted
in fulfilment of the requirement for the degree of Bachelor of Mechatronic Engineering(Hons.)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2015/2016

DECLARATION

"I declare that this report entitle "Aerial Monitoring on Mango using Machine Vision Techniques" is the result of my own research except as cited in the references. This report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : OH KOK KEN

Signature : 23/6/2016

To my beloved father and mother

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First and foremost, I would thank Universiti Teknikal Malaysia Melaka (UTeM) for providing me an opportunity to conduct my final year project. I would like to express my deepest gratitude to my final year project's supervisor Madam Nursabillilah binti Mohd Ali from Faculty of Electrical Engineering Universiti Teknikal Malaysia Melaka (UTeM) for her essential guidance and moral support towards completion of this report.

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ABSTRACT

The entire project deals with development of shape identification algorithm and image training classification with Histogram of Oriented Gradient. The focus would be the process of detection and summing up the total number of mango on its tree with a drone and display it in MATLAB. The hypothesis made is the system could at least achieve the detection rate of 60%. The conventional method in harvesting mango has its limitation which leads to the degradation of mango's quality. Besides, the rate of production and the structure of the tree will be affected too. Previous researches have proven the significant role of machine vision to be embedded in agricultural technology. Nonetheless, the usage of a drone with an algorithm of image processing could be employed for a better and more precise mango's farming. The obvious benefit of utilizing drone is its capability to hover around the upper part of tree which is normally not reachable by human. The device could hover around mango trees and count the detected mango in a short operating time. It differentiates the mango from its background based on the images captured. The experiments were done in indoor as well as outdoor. Indoor experiment is less prone to noise meanwhile; outdoor experiment is sensible to noise. Eccentricity and form factor is the determining criteria for shape and size judgment. Machine vision's classification using training classifier would be another method under research. Analysis of obtainable result would be tabulated of based on confusion matrix. The detection rate in all experiments should exceed a detection rate of approximately eighty percent. In short, it provides a quick review for the mango grower, agricultural developer and investor.

ABSTRAK

Keseluruhan projek berkaitan dengan pembangunan algoritma berdasarkan pengenalan bentuk dan latihan klasificasi imej dengan theori Histogram of Oriented Gradient. Tumpuan projek ialah pengesanan dan merumuskan jumlah mangga di atas pokok mangga. Hipotesis projek adalah sistem dapat mencapai kadar pengesanan 60% ke atas. Kaedah konvensional dalam penuaian mangga mempunyai kelemahan yang membawa kepada penurunan kualiti mangga itu. Selain itu, kadar pengeluaran dan struktur pokok itu akan terjejas juga. Kajian terdahulu telah membuktikan peranan penting penglihatan mesin yang boleh digunakan dalam teknologi pertanian. Namun begitu, penggunaan pesawat kawalan jauh dengan algoritma pemprosesan imej boleh digunakan untuk pertanian mangga yang lebih baik dan tepat itu. Manfaat yang jelas menggunakan pesawat kawalan jauh adalah keupayaan berlegar sekitar bahagian atas pokok yang biasanya tidak dapat dicapai oleh manusia. Peranti ini boleh berlegar sekitar pokok mangga dan mengira mangga dikesan. Kajian ini telah dilakukan dalam tempat yang mengalami kadar perubahan cahaya yang tinggi serta di tempat yang kadar perubahan cahaya yang rendah . Kesipian dan faktor kebentukan menjadi kriteria untuk menentukan bentuk dan saiz setiap mangga. Klasifikasi menggunakan latihan pengelas mesin penglihatan akan menjadi satu lagi kaedah di bawah penyelidikan. Analisis keputusan diperolehi akan jadual daripada berdasarkan matriks kekeliruan yang berasaskan kaedah pembelajaran mesin. Dalam semua experimen, kasar ketentuan akan melebihi hampir lapan puluh peratus. Kesimpulannya, projek menyediakan satu kajian dan analisa cepat untuk penanam mangga, pemaju pertanian dan pelabur.

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LIST OF ABBREVIATIONS

FYP	-	Final Year Project
MATLAB	-	Matrix Laboratory
RGB	-	Red, Green and Blue
HSI	-	Hue, Saturation and Intensity
HSV	-	Hue, Saturation and Value
CCD	-	Coupled Charge Camera
CMOS	-	Complementary Metal Oxide Semiconductor

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CHAPTER 1

INTRODUCTION

1.1 Motivation

In pre-historic time, most human race survives and builds up their early civilization via agricultural-based living. Food like tropical fruit remained to be a vital source of fiber and minerals to all livings. Meanwhile, in economic wise, agricultural sector has shifted from a field merely outsourcing product to fit industrialization purpose to an utmost importance field [1]. It provides increment in exports revenue, employment rate and level of food security of developing countries. In [1], mango as local tropical fruit has become the main focus in horticulture industry particularly in developing countries for exporting purpose.

50% of all tropical fruit produced worldwide is mango. Mango's production has skyrocketed over a decade to fulfill the world wide's demand, especially United States of America and Europe. In addition, most mango producing countries has potentials to increase the production rate.

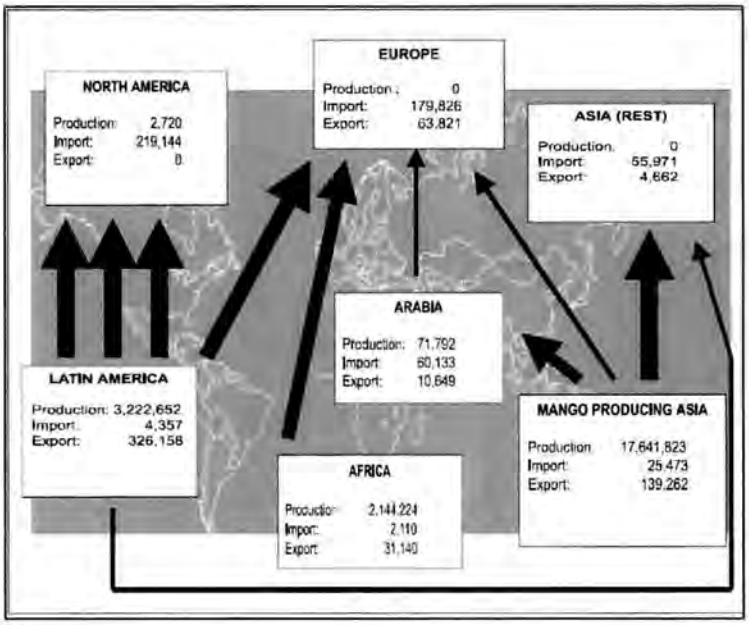

Figure 1.1: The Production, Import and Export Statistics of Mango in Metric Tons [1].

According to [2], one of the major fruit produced in Malaysia is mango. It marks the export quantity of 126,000 metric tonnes in the year of 2002. [3] also iterates that tropical fruit are highly demanded and its valuable for market competition with other fruits. Pineapple, papaya and mango would be the most common tropical fruits. Mango has been categorized as a year-round demanded tropical fruit in European market. Its exoticness promotes penetrability into European market. They forecast the possible increment import volume for several major tropical fruits with largest percentage increment for mango which is 9.7%.

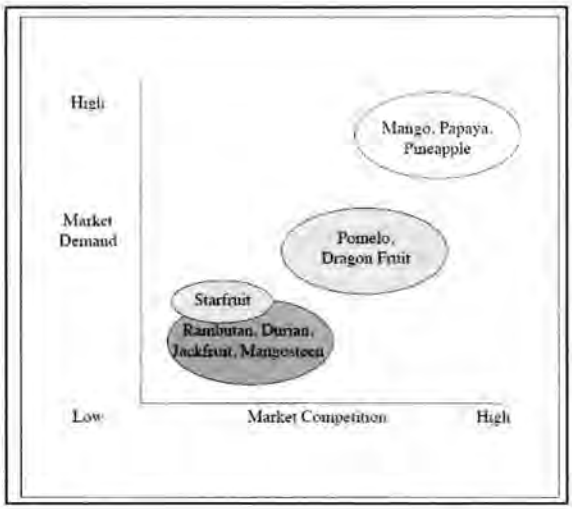

Figure 1.2: Positioning Map for several tropical fruits in European market [2].

In order to promote Malaysia's local mangoes as tastier and tender, investment is needed for various profitable segments or platforms. Japanese expresses their affection towards mangoes because of its texture around mid-year 2007 [5]. In certain point of view, mango was accessed as it contains the most acceptable sweet taste with its texture too. Besides, respondents were showing positive attitude towards mango as they were most likely to purchase.

In Malaysia alone, approximately 26% of the Gross Domestic Product is contributed by agricultural sector. Within the cultivated area, 6.4% is allocated for fruits particularly mango. According to Department of Agriculture, in year 2013, 5,270.4 hectares of land is mango farm with a harvested area of 3259.8 hectares. The total value of production costs around RM 61,958,000. The statistical figure denotes the significance of maintaining and further improving the amount of harvested product which in turn could contribute to Malaysia's economy [5].

1.2 Problem Statement

Sustainable agricultural concept requires an adequate and optimum level of modern technology to yield a good quality crop. There were numerous obstacles encounter by mango's grower to nurture a standardized product. One of the issues troubling agriculture's entrepreneur is heavy loss due to damaged and spoilt mangoes [6]. The common reasons were inadequate knowledge in technical and management wise. For instance, manual plucking and vibrator's assistance method to harvest goods is a leading factor. Both ways of harvesting without proper judgment made on the crops would surely dampen the production rate and generated revenue. Shortage in skilled labour will result in unripe fruit to be pluck off or over-ripened mango becomes useless. In addition, challenging or unpredictable environmental changes would also affect the yields. Mango tree is not sustainable to windy condition. For example, mango will be blown and sway in the wind. Most mangoes will turn bad after falling into bare ground without any protective wrapper.

Machine vision technique based on shape analysis will be applied to tackle the issues arises [7]. Nevertheless, a compatible colour detection algorithm will be complement for the former method to further improve the system's efficiency. Both of the methods used will quantify the related parameters in the project. A better perspective of monitoring system using aerial vehicle is expected to further enhance the result. Relevant experiments will be conducted throughout the project to offer a judgment that applied machine vision technique is capable to replace human workforce. The allocated device will scan the ripeness of the mango and provide logical justification.

1.3 Objective

The main objectives of conducting the project are:-

1. To develop an algorithm for mango identification by extracting specific image of ripe mango on the tree.
2. To develop an intelligent shape detection system based on the extracted mango features.
3. To validate the performance of the system using a remote-controlled aerial vehicle.

1.4 Scope

The scopes of the research are listed as follow:-

1. The project covers the development of algorithm and verification of image processed via an aerial vehicle.
2. A non-movable camera is attached on the lower part of the aerial vehicle.
3. Surrounding lighting, shadow's visibility and occlusion will be taken as algorithm's parameters while conducting field test.
4. The developed algorithm is supposed to navigate on a single mango tree only.
5. The height of flight test shall not be more than 10 meters. Camera attached is position properly so that it can capture appropriate images.
6. The formatted system is applied to mango's detection on its tree only.
7. Performance of real time test would vary depending on lighting and shadow formation constraint.