



**OBJECT DETECTION USING IMAGE
PROCESSING TECHNIQUES:
COCONUT AS A CASE STUDY**

By

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LIST OF ABBREVIATIONS

CHT- Circular Hough Transform

et al. - and others

FCD- Fast Circle Detection

FCHT- Fast Circle Hough Transform

GM- Geometric Moment

GMI- Geometric Moment Invariant

HT- Hough Transform

ISEF- Infinite Symmetric Exponential Filter

MGD- Malayan Green Dwarf

MRD- Malayan Red Dwarf

MT- Malayan Tall

MYD- Malayan Yellow Dwarf

PGM- Portable Gray Map

RCD- Randomized Circle Detection

RHT- Randomized Hough Transform

ABSTRAK

Terdapat pelbagai aplikasi yang menggunakan pemprosesan imej untuk mengenalpasti sesuatu objek yang mempunyai pelbagai bentuk dan menjadikan proses pengenalpastian tugas yang sukar. Di dalam laporan ini, fokus utama ialah untuk mengenalpasti objek yang berbentuk bulat dari sesuatu imej. Terdapat beberapa teknik yang digunakan seperti penapis terasing, Penjelmaan Bulat Hough (CHT), persilangan perentas dan Momen tak varian. Sebelum teknik-teknik ini digunakan, pemprosesan awal dan persegmenan imej dilakukan dahulu. Penyamaan histogram digunakan dalam pemprosesan awal sementara pengesanan sisi dan penapisan morfologi digunakan di dalam persegmenan imej. Objek tunggal diuji menggunakan kedua-dua teknik, CHT dan persilangan perentas untuk dinilai. Keputusannya, proses pengenalpastian objek tunggal dengan menggunakan CHT mempunyai peratusan yang tertinggi iaitu 87.5% jika dibandingkan dengan persilangan perentas, 85%. Untuk pengenalpastian beberapa objek, CHT digunakan dan peratusan untuk objek pertama ialah 87.5%, diikuti objek kedua 92.5%, 77.5% untuk objek ketiga dan yang keempat 87.5%. Teknik Momen tak varian digunakan untuk mengekstrak bentuk sesuatu objek dan mengenalpasti kehadirannya. Dari 50 imej yang diuji, 90% memberikan keputusan yang positif. Kajian ini boleh diadaptasikan ke sistem robot memanai yang boleh memetik kelapa secara automatik dari pokok. Dengan menggunakan pemprosesan imej, proses memetik akan menjadi lebih mudah dan sesuai daripada memetik secara manual.

ABSTRACT

The use of computers to analyze images has many potential but, the variability of the objects makes it a challenging task. In this thesis, the main idea is to detect an object (coconut) from an image. Several techniques have been utilized namely, the separable filter, Circular Hough Transform (CHT), chord intersection and moment invariant. Before applying these techniques, the preprocessing and image segmentation steps need to be performed in priori. Histogram equalization is utilized in preprocessing step meanwhile edge detection and morphological filtering have been employed in image segmentation step. Single object has been experimented to evaluate the two (2) techniques, CHT and the chord intersection. Based on the results obtained from single object detection, the CHT achieves higher percentage, 87.5% than chord intersection technique, 85%. For multiple objects detection, the CHT technique has been used and the highest detection for the first object is 87.5% followed by 92.5% for the second object, 77.5% for the third object and the last object is 67.5%. The moment invariant technique has been used to extract the shape of the object and detect its presence. From 50 images that have been experimented, 90% show positive result. This research can be adopted for climbing robotic system that can automatically pluck the coconut from a tree. Using image processing techniques, the gripping process will be easier and convenient than manual plucking.

CHAPTER 1

INTRODUCTION

1.1 Overview

There are numerous applications that use image processing to detect the object with different patterns and shape. Coconut detection method is a new research evolved where no researcher has been tried to detect coconut according to the literature survey. Several researches had been done on detecting fruits such as avocado and orange [Jimenez, 1999]. In Malaysia, coconut has been planted either for daily uses or commercialize. Thus, as the coconut provides lots of benefit, this research selected coconut as the object of interest.

The coconut detection process confront problem such as the complex background of the image. In this case, the complex background affect by coconut leaf, stem and flower. The complex image that consists multiple objects also contribute problem to achieve the goal. In several images, the coconut appears in a bunch and overlaps one another that can affect the detection process.

Therefore, for the purpose of this research, the Hough Transform (HT) will be utilized to implement the detection process of a given object. The HT is a well known technique in image processing. The main role of HT is to transform the image to a parameter space where particular configurations identify instances of a shape in detection phase. The HT had been used to solve the object detection process such as in

detecting the tumors in X-Ray image [Duda, 1972] and fruits such as orange [Jimenez, 1999].

Moment invariant technique also had been investigated to classify between the object and the background (leaf, stem and flower). Moment invariant had been proven as an effective technique for shape descriptor of binary or gray scaled images in vision application [Phiasai, 2001, Puteh, 2004, Shahrul Nizam, 2005]. The vector produced by the moment invariant technique for a particular object may be different for object rotation, scale and size. In this research, the HT and moment invariant technique have been utilized in feature extraction phase to identify the object.

1.2 Problem Statement and Its Significance

Locating an object from a given image is a difficult task as different object appears in different pattern. In this research, the main focus is to detect coconut as the object of interest from an image. The appearance of the object is very important as the appearance may disturb the detection process of the object. In some images, multiple objects appear and overlap one another which can cause problem in locating the object.

The complex background also contributes to the problem on detecting the object. There are lots of unnecessary information found in the image such as the coconut leaf, stem and flower. Therefore, image needs to be preprocessed and image segmentation needs to be carried out to reduce the unwanted information so that the object can be clearly identified.

This research selects the coconut as the object of interest since coconut provides almost all necessities of life like food, drink, oil, medicine, timber, thatch, mats, fuel, cosmetic and domestic utensils. Consequently, it has been called the 'tree of heaven' or 'the tree of life'. For the agroforestry, coconut tree is used as coastal stabilization and windbreak.

Due the increasing demand for coconut usage, new method has to be explored to assist the gripping process. It helps to pluck the coconut from a tree using image processing technique and it will be faster and convenient than the manual plucking.

1.3 Research Objectives

The objectives of this work are:

- i. To investigate and evaluate the performance of the separable filter, Circular Hough Transform (CHT) and chord intersection in detecting a circular pattern.
- ii. To investigate and evaluate the performance of the moment invariant to classify the object of interest.
- iii. To evaluate the performance of two (2) edge detection methods namely Sobel and Canny edge detector.
- iv. To obtain the best object detection algorithm in detecting multiple objects in an image.

1.4 Research Methodology

In this research, some limitations have been marked. The grayscale image has been used throughout this work to achieve the above objectives. There are five (5) processes for research methodology namely image acquisition, preprocessing, image segmentation, feature extraction and final result. Image acquisition is a process to capture the image using digital camera. For preprocessing, the histogram equalization had been used while in image segmentation, edge detection and morphological filtering had been utilized. Basically, this research focuses on the feature extraction process that employed several techniques namely the separable filter, the Circular Hough Transform (CHT), the chord intersection and moment invariant to identify the object of interest. The separable filter, CHT and chord intersection techniques are used to detect the object while the moment invariant is used to classify the object and the background. The CHT assisted by the separable filter and chord intersection have been used in detecting a single object. Finally, the best technique obtained for single object detection is utilized to detect multiple objects in an image.

1.5 Thesis layout

This thesis is composed of five (5) chapters. Each of the chapter is described as follows:

- i. Chapter 1: Consists of the problem statement, objectives, scope and thesis layout.
- ii. Chapter 2: Presents the literature review of several previous work that related to CHT, chord intersection and moment invariant. This chapter also describes the

fundamental equation and algorithms for these techniques. In addition, this chapter also discusses the equation for histogram equalization, edge detection and morphological filtering method.

- iii. Chapter 3: Discusses the details methodology adopted in this work from the image acquisition process until the feature extraction process and the algorithms had been developed to achieve the result.
- iv. Chapter 4: Presents and discuss all the results obtained after using the proposed object detection techniques and methods.
- v. Chapter 5: Presents the conclusion of the research, the contribution and future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The use of computer to analyze images has many potential applications for automated agricultural tasks. But the variability of the agricultural objects makes it very difficult to adapt the existing industrial algorithm to the agricultural field. There are many processes needed in the agricultural domain where decision is made based on the appearance of the product. Humans are easily able to perform any tasks but recently several approaches had been studied to automate the human task to robotic.

This research is carried out in order to assist the gripping task of the object in the agricultural domain. The object that has been considered to be used in this work is the *Cocos Nucifera* which is also known as the coconut. Most of the coconut appears in circular shape. Thus, the techniques for circle detection need to be considered to locate the coconut.

Hough Transform (HT) is widely known as a robust technique in detecting line, circle, ellipse and arbitrary shape. In this research, the Circular Hough Transform (CHT) and chord intersection have been adopted to accomplish the detection process. Both techniques are derived from the HT. Meanwhile the Geometric Moment Invariant (GMI) technique has also been adopted to distinguish the object itself and the background of the image.

This chapter will illustrate the strength and robustness of the HT in detecting the circular shape. In addition, recent versions of the HT have been studied to prove that the chosen technique is a good technique to accomplish the detection process.

2.2 Object of Interest - Cocos Nucifera

Coconut is a great gift of nature. Coconut is known differently in several countries such as *niyog* in Philippines, *kelapa/nyior* in Malaysia/Indonesia, *kokosplame* in German and *niu* in Fiji/Papua New Guinea/Polynesia. Coconut grows in rainforests and other tropical climate. Its natural habitat was the narrow sandy coast but is now found on soils ranging from pure sand and to clays and from moderately acidic to alkaline. It is non-invasive and people have been responsible for its spread inland from its natural habitat. It thrives under warm and humid conditions but still can tolerate short periods of temperatures below 21°C. Coconut is known scientifically as *Cocos Nucifera* and is a member of Family *Arecaceae* (palm family). Coconut is native to coastal area of South East Asia (Malaysia, Indonesia and Philippines) and Melanesia. In prehistory times wild forms are believed to have been carried east on ocean currents to the tropical pacific island (Melanesia, Polynesia and Micronesia) west to coastal India, Sri Lanka, East Africa and tropical island in India ocean. In these regions, the palms are able to establish themselves on the sandy and coralline coasts. The coconut is an important plant in the lives and economies of people in South East Asia such as Burma, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam, Africa, Indian Subcontinent and Indian Ocean, Melanesia, Polynesia, Micronesia and Central America/Caribbean.

There are two varieties according to size and stature of the palm. The first one is 'Talls' and the second one is 'Dwarfs'. Talls are more commonly grown around the world. Tall varieties are cross-pollinated and are thus highly variable as seen in the wide variation in characteristics such as size, shape, and color of the fruit and yield. Meanwhile dwarf is largely self-pollinated and thus are genetically more homogeneous. The size of the coconut tree depends on the growth year of the tree. A 40 year old palm tree attains a height of 20-22m and a 80 year old palm can attain a height of 35-40m. The canopy has a diameter of 8-9m [Chan, 2005].

In Malaysia, coconut is planted for either personal use or commercialization. There are several varieties of commercial coconut that had been planted in Malaysia like Malayan Tall (MT), Malayan Yellow Dwarf (MYD), Malayan Green Dwarf (MGD), Malayan Red Dwarf (MRD), MAWA, Rennel Tall, Tagnanan Tall, Matag and Pandan. MAWA and Matag are hybrid coconut that had been planted commercially. In peninsular Malaysia, the plantation of coconut in year 1999 are around 115 718 hectare. The largest commercialize coconut plantation in peninsular Malaysia is in the state Johor, followed by Perak and Selangor. Several of the captured coconut images are shown below.



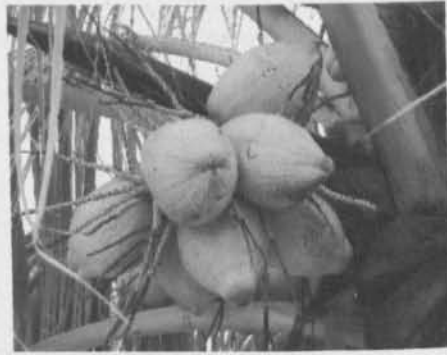
(a)



(b)



(c)



(d)



(e)



(f)

Figure 2.1: Coconut images

2.3 Standard methodology

Object detection from an image is a challenging task in image processing. Several processes need to be performed to simplify the extraction of the object. The standard method utilized in this research shown in Figure 2.2.

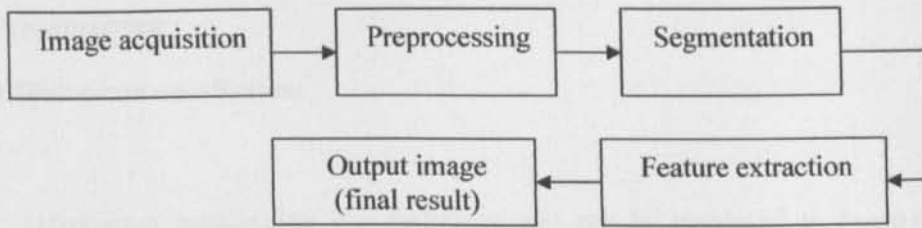


Figure 2.2: Standard methodology for the proposed object detection

Image acquisition process is a crucial step in the object detection. The image is captured using digital camera. The image size needs to be transformed into a specific size in doing the research. The captured image needs to be enhanced before the CHT, chord intersection technique and GMI technique are used.

Next, the image undergoes the preprocessing step. In this process, image is enhanced in order to improve the quality of the image. Then, the image undergoes a segmentation process. The segmentation process is a process that can highlight the object of interest using numerous methods such as edge detection, region growing and shrinking, clustering technique and morphological filtering. The segmentation process is used to highlight the object from the background of the image to make the region clearly seen.

The final process is the feature extraction. In this process, several techniques have been employed to identify the object of interest. In this research, four (4) techniques have been utilized to identify the object namely the separable filter, CHT, chord intersection and GMI.