

**LAND USE SEGMENTATION USING IMAGE EDGE DETECTION,
MARKER-CONTROLLED WATERSHED AND K-MEANS CLUSTERING
TECHNIQUES**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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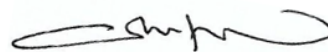
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LAND USE SEGMENTATION USING IMAGE EDGE DETECTION, MARKER-CONTROLLED WATERSHED AND K-MEANS CLUSTERING TECHNIQUES

CHONG ZI QING



This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Computer Networking) with Honours.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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2021

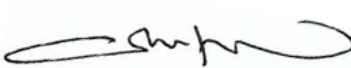
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DEDICATION

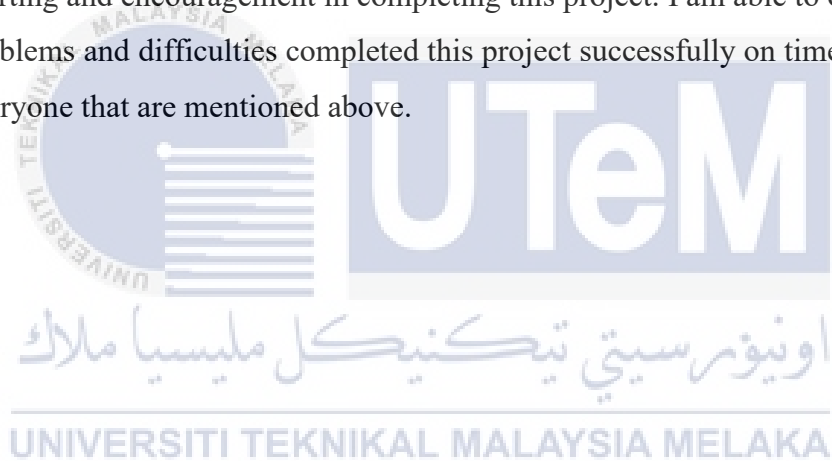
This study is dedicated to my beloved mother, Loke Lai Thai for her support and understanding. Her care and accompany is necessary for me to complete this project on time. Moreover, it is also dedicated to my supervisor, Dr. Othman bin Mohd for his great guidance and advices. Lastly, this study is also dedicated to my fellow friends. They really give meaningful suggestion and share their knowledge on how to perform this project in a better way.



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ABSTRACT

Land use is one of the basic data in geographic information system (GIS). It is important for the planning to meet the needs of people and safeguard the future resources. Satellite image is an important source of input but it is difficult to segment the land based on different uses due to high resolution satellite data. Therefore, image processing is necessary to extract this basic information from satellite image as it is a method that use any algorithm to perform operation which can solve this problem. In this project, image segmentation is focused because it is defined as the process that partition or divide an image into homogeneous pixel groups (Verdonck, L., et. al., 2019). The main purpose of the project is to segment the Malacca land and then identify the different types of land use. There are many techniques for image segmentation thus several of them have been identified. Image Edge Detection, Marker-Controlled Watershed as well as K-means clustering are the techniques used to determine the contours of objects within the satellite image in this project. Then, evaluate the three (3) techniques of segmentation by conducting comparison on the output of each technique. The best technique is identified after the analysis conducted.

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ABSTRAK

Penggunaan tanah adalah salah satu data asas dalam GIS. Penggunaan ini adalah penting untuk perancangan yang dapat memenuhi keperluan orang dan meletarikan sumber daya bagi masa depan. Imej satelit adalah salah satu sumber input yang penting tetapi pembahagian tanah berdasarkan penggunaan yang berbeza adalah sukar disebabkan data satelit yang beresolusi tinggi. Oleh itu, pemprosesan imej diperlukan untuk memperoleh maklumat asas ini dari imej satelit kerana proses ini merupakan kaedah yang menggunakan sebarang algoritma untuk melakukan operasi yang dapat menyelesaikan masalah ini. Projek ini akan berfokus kepada *image segmentation* kerana ia merupakan proses pembagian imej ke dalam kumpulan *homogeneous pixel* (Verdonck, L., et. al., 2019). Tugas yang kena dilaksanakan adalah membahagikan tanah Melaka, dan kemudian mengenal pasti jenis-jenis penggunaan tanah. Beberapa teknik untuk segmentasi gambar telah dipilih dan diambil daripada kebanyakan teknik yang berwujud. Dalam projek ini, teknik *image Edge Detection*, *Marker-Controlled Watershed* dan *K-means clustering* digunakan untuk menentukan garisan kontur objek dalam gambar satelit. Selain itu, penilaian tiga (3) teknik *segmentation* ini perlu dijalankan melalui perbandingan ke atas output setiap teknik dan akhirnya teknik yang terbaik dipilih.

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LIST OF ABBREVIATIONS

PSM	-	Projek Sarjana Muda
UTeM	-	Universiti Teknikal Malaysia Melaka
GIS	-	Geographic Information System
LULC	-	Land Use/Land Cover
RMS	-	Rate-Monotonic Scheduling
CAGR	-	Compound Annual Growth Rate
PDE	-	Partial Differential Equation
ANN	-	Artificial Neural Network
FCM	-	Fuzzy C Means
EM	-	Expectation Minimization
PSNR	-	Peak Signal-to-Noise Ratio
USGS	-	United States Geological Survey
LISS	-	Linear Imaging Self Scanning Sensor
IRS	-	Indian Remote Sensing Satellites



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CHAPTER 1

INTRODUCTION

1.1 Introduction

Land use is one of the basic data in geographic information system (GIS). It is important for the planning to meet the needs of people and safeguard the future resources. Previous research done by Sowmya, D. R., et. al. (2018) stated that Land Use/Land Cover (LULC) mapping plays an important role in many land management applications, for example to create community map and proper urban planning. Satellite image is an important source of input for land use information but it is difficult to segment the land based on different uses due to high resolution satellite data. Image processing is a method that use any algorithm to perform some operations on an image to extract useful information from it, thus it can used to extract this basic information from satellite image. Satellite image processing consists of several techniques which are enhancement, fusion, segmentation, feature extraction, change detection, compression, feature detection, classification and. Image segmentation are focused to distinguish the object based on different types of land use from the satellite image.

Image segmentation is the partitioning of an image into homogeneous pixel groups. (Verdonck, et. al., 2019). Its goal is to change or simplify the representation of an image into more meaningful thing that is easier to be analyzed. It is the process of assigning a label to every pixel such that pixels with the same label share particular characteristics likes tone, texture or color. It involves detecting and classifying individual objects within the image, for example locate objects in satellite images such as road, forests, tree and etc.

Nowadays, image segmentation is widely applied for computer vision, face recognition, medical imaging, number plate identification and etc. Furthermore, it also has been used in many workplaces especially medical and security. In this project, image segmentation is used to segment the Malacca land and then identify the different types of land use. Supervised techniques perform classification through the training of machine or system where the training sets and target pattern are provided for the system. Unsupervised technique performs classification by generating clusters based

on similar spectral features inherent in the image without training the provided samples.

There are several techniques in image segmentation including region based method, edge based method, thresholding method, watershed based method, clustering based method, Artificial Neural Network Based (ANN) based method and Partial Differential Equation Based (PDE) method. In this project, the covered techniques are image edge detection, Marker-controlled watershed and k-means clustering techniques. Comparison between the output of these 3 techniques to identify the best technique for land use segmentation of Malacca satellite image has been carried out. Besides, unsupervised classification is implemented since there is no dataset or samples are acquired and used to classify the different types of land use. It is fairly quick and easy to implement for non-professional but it has to spend time to identify and label the classes.

1.2 Problem Statement (PS)

Land use is the term which described the use of land for humans. Nowadays, there are several common land use which are recreational, transport, agricultural, residential and commercial. It is important data used in the planning to meet the needs of people and safeguard the future resources. Besides, the land use information is necessary for the land management practices which aim to solve the natural resource management issues for example, the salinity and water quality. There are many researches about land use. One of the found researches was conducted by Kim, C. (2016), its purpose is to use satellite imagery to carry on the classification of the land use and land cover status, the identification of land use changes especially deforestation and forest degradation in Lombok Island in the past 20 years.

Since it is difficult to distinguish the land based on different uses due to high resolution satellite data, this project aims to solve this problem to segment land and identify different types of land use for Malacca. In this process, some problems can directly influence the motives of this project. These kinds of problems would lead to poor result or output of the project. Therefore, it is important to overcome these problems in order to find out the best techniques for land use segmentation. A good output from the satellite image segmentation is necessary for us to identify the different

types of land use correctly and efficiently. The problem statements (PS) are summarized in the Table 1.1.

Table 1.1: Summary of Problem Statement

PS	Problem Statement
PS1	Difficult to distinguish the object based on different types of land use from the satellite image.
PS2	Lack of understanding about different segmentation techniques.
PS3	There are too many techniques can be applied for image segmentation.

1.3 Project Question (PQ)

Based on the problem statement summarized in Table 1.1, the project questions have been figured out to overcome the issues that may happen in the land use segmentation. The problem questions are:

- i. It is difficult to distinguish the objects from the satellite image with naked eyes. Therefore, it is necessary to find the technology or techniques that allow us to do that. How to distinguish the objects from satellite image?
- ii. Lack of understanding about different techniques would increase the possibilities of choosing the wrong or worse technique. Therefore, it is important to know the advantages and disadvantages of each technique. What are advantages and disadvantages for each of the selected segmentation techniques?
- iii. From the present-day knowledge society, there are too many techniques can be applied for image segmentation. Therefore, the comparison of each output is necessary to be conducted to find out the best techniques. Which techniques can be applied to produce better results?

These project questions (PQ) are summarized in the Table 1.2.

Table 1.2: Summary of Project Question

PS	PQ	Project Question
PS1	PQ1	How to distinguish the objects from satellite image?
PS2	PQ2	What are advantages and disadvantages for each of the selected segmentation techniques?
PS3	PQ3	Which techniques can be applied to produce better results?

1.4 Project Objective (PO)

The problem statement as mentioned in Table 1.1 and project questions mentioned in Table 1.2 are used to embark the objectives of this project. This project objectives (PO) are summarized in Table 1.3.

Table 1.3: Summary of Project Objectives

PS	PQ	PO	Project Objective
PS1	PQ1	PO1	To identify techniques of land use segmentation.
		PO2	To apply three (3) techniques which are image Edge Detection, Marker-controlled Watershed and K-means Clustering to determine the contours of objects within the satellite image.
PS2 PQ3	PQ2 PQ3	PO3	To evaluate the 3 techniques to identify the best technique for land use segmentation.

1.5 Project Scope

The project study was bounded to the following scope as mentioned below:

The land use segmentation is conducted on the satellite image of Malacca city in Malaysia and the image is downloaded from Google Earth. Google Earth is selected because this platform is free and easy for us to download the image. This image has

been downloaded on 26 March 2021 and it is with the highest resolution available in Google Earth which is 4800 * 2782 pixels.

The satellite image is processed with 3 different segmentation techniques in Matlab that is running on Windows system. Matlab is selected because this software allows us to code and debug much faster.

There are six (6) segmentation regions, which consists of Residential, Green spaces, Commercial and industrial area, Sediment, Coastal area and Deep Sea.

1.6 Project Contribution (PC)

In this project, the best segmentation technique is identified to distinguish the object based on different types of land use of Malacca from the satellite image. This can contribute to the further research or study of image processing in the many fields of science and technology especially for remote sensing and computer vision. Furthermore, the knowledge obtained from this project can help non-professional in many workplaces like land use mapping, environmental monitoring, and land resources planning and management.

1.7 Report Organization

In this project, there are 6 chapters to be discussed. The report started from chapter 1 that is introduction until chapter 6 which is conclusion.

Chapter 1: Introduction of the project is discussed in this chapter. Introduction states about the project background, problem statement, the project questions and the project objectives. Problem statement directly affected and decided what is the project questions and objectives. Furthermore, this chapter also states about the project scope and contribution.

Chapter 2: This chapter discuss about the literature review of the project. Literature review states about the related work done by some researcher previously. Moreover, this chapter also states about the critical review of current problem and justification, as well as the proposed solution based on the related researches.

Chapter 3: Methodology of the project is discussed in this chapter. Methodology describes every stage for the selected methodology and the activities carried on in each stage. Besides, all the activities are explained stage by stage in the project milestones.

Chapter 4: This chapter discuss about the implementation of this project. Implementation states about the hardware and software required in this project and describes all the steps involved in the implementation. Besides, the progress of the development status is needed to be recorded.

Chapter 5: This chapter discuss about the testing and analysis of this project. Testing and analysis state about the details on how to compare the output of each segmentation technique and the result of which is the best technique for the land use segmentation.

Chapter 6: The conclusion of this project is discussed in this chapter. Conclusion consists of the project summarization, project contribution, project limitation and future works which can be done to improve the project.

1.8 Conclusion

Land use is one of the basic data in GIS. It is important for the planning to meet the needs of people and safeguard the future resources. Satellite image is an important source of input but it is difficult to segment the land based on different uses due to high resolution. Therefore, image processing is method to extract this basic information from satellite image. In this project,

image segmentation is focused because it can partition an image into homogeneous pixel groups or image objects. There are many techniques for image segmentation thus image edge detection, Marker-controlled watershed and K-means clustering have been chosen to carry out comparison between them in order to identify the best technique.

The objectives of this project are to identify segmentation techniques for land use as well as apply 3 techniques which are image edge detection, Marker-controlled watershed as well as K-means clustering to determine the contours of objects within the satellite image. Then, evaluate the 3 techniques of segmentation. On the other hand, the scopes of the project are satellite image of Malacca downloaded from Google Earth and Matlab is used to carry out the project. The target at the end of this project is to segment the Malacca land and identify the different types of land use like residential,