

**CLASSIFICATION OF SATELLITE IMAGE USING  
MAXIMUM LIKELIHOOD AND ISODATA TECHNIQUES**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

## BORANG PENGESAHAN STATUS LAPORAN

JUDUL: CLASSIFICATION OF SATELLITE IMAGE USING MAXIMUM LIKELIHOOD AND ISODATA TECHNIQUES

SESI PENGAJIAN: 2020 / 2021

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CLASSIFICATION OF SATELLITE IMAGE USING  
MAXIMUM LIKELIHOOD AND ISODATA TECHNIQUES

CHUA XIN YING



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

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY  
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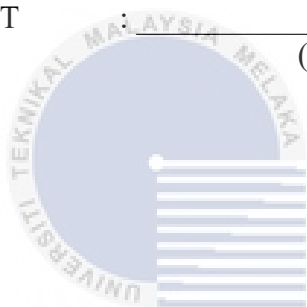
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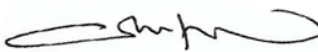


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## DEDICATION

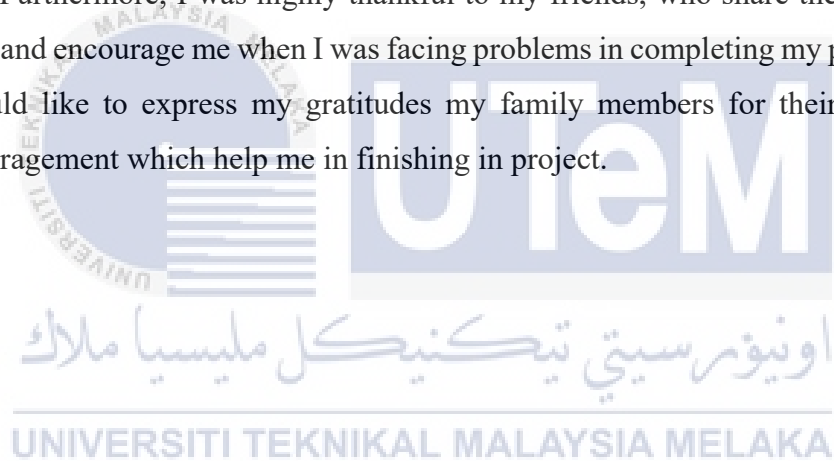
This study is dedicated to my parents, Chua Yong Peng and Ong Swee Kiau who inspired me and support me on financial, moral and emotional in completing this study. Without their support, I may not be able to complete this. Besides, I decided this study to my supervisor, Gs. Dr. Othman Bin Mohd. He gave me a lot of advice, help me in understanding more about image processing and guide me in completing this study. Lastly, I dedicate to my friend, Chong Zi Qing who share her knowledges in image processing with me and encourage me to complete my project.



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## ABSTRACT

Satellite Image Processing is important in Research and Development field. It is taken by the artificial satellite, and the photo taken is processed by computer to extract the data in the photo. Processing the image by using manual methods consumes a lot of time. Besides, the expert must know well about the area covered by the satellite image and the knowledge and familiarity of the expert will directly affect the efficiency and accuracy of the classification. Therefore, image classification by computer is introduced. There are a lot of techniques introduced by the previous researcher to classify the satellite image and the techniques are mainly divided into two types, which are Supervised and Unsupervised Classification. The example of supervised classification method is Maximum Likelihood and unsupervised classification method is ISODATA. The two techniques were used to identify the objects in the satellite image. The process of comparing results based on the two techniques were carried out to identify the best classification techniques. The comparison of the output was conducted based on the percentage of accuracy.

## ABSTRAK

Pemrosesan imej satelit adalah antara bidang yang penting dalam bidang Penyelidikan dan Pembangunan. Foto akan diambil oleh satelit buatan, dan diproses oleh komputer untuk mengekstrak data dalam foto tersebut. Pemrosesan gambar dengan menggunakan kaedah manual memerlukan banyak masa. Selain itu, penganalisis mesti mengetahui bidang yang diliputi oleh imej satelit dan pengetahuan dan keakraban penganalisis akan mempengaruhi kecekapan dan ketepatan klasifikasi secara langsung. Oleh itu, pengkelasan gambar oleh komputer diperkenalkan. Terdapat banyak teknik yang diperkenalkan oleh pengkaji sebelumnya untuk mengklasifikasikan imej satelit dan teknik tersebut dibahagikan kepada dua jenis, iaitu Klasifikasi Terbimbing dan Tidak Terbimbing. Antara contoh kaedah Klasifikasi Terbimbing ialah Kemungkinan Maksimum dan Klasifikasi Tidak Terbimbing ialah ISODATA. Kedua-dua teknik digunakan untuk mengenalpasti objek dalam gambar satelit. Proses perbandingan hasil dapatan antara dua teknik dilakukan untuk mengenalpasti teknik klasifikasi yang terbaik. Perbandingan hasil dapatan akan dilakukan berdasarkan peratusan ketepatan.



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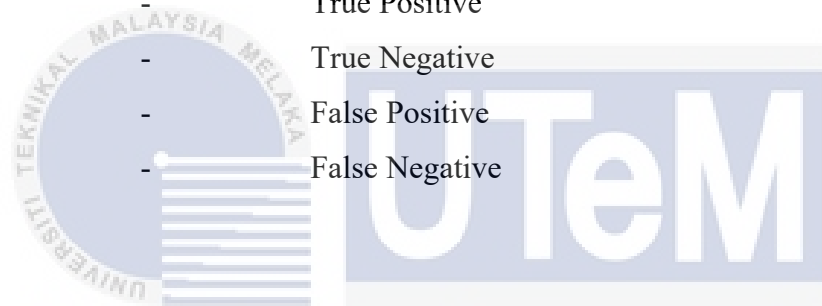
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## LIST OF ABBREVIATIONS

FYP	-	Final Year Project
UTEM	-	Universiti Teknikal Malaysia Melaka
ISODATA	-	Iterative Self-Organizing Data Analysis
MLE	-	Maximum Likelihood Estimation
MLC	-	Maximum Likelihood Classification
GUI	-	Graphical User Interface
TP	-	True Positive
TN	-	True Negative
FP	-	False Positive
FN	-	False Negative



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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Satellite images are one of the most important and powerful tools used to collect the photo of Earth (Oakfield, WI Tornado, n.d.). It contains useful information, such as the shape of the river, shape of the road, coverage of the urban area and forest area. The evolution of satellite images enhanced the process of data collection, by reducing the time taken for data collection and facilitate the process of collecting data.

In the beginning, satellite image is used in the environmental and military field. It is used more and more in the field of agriculture, map production, planning of national land, forestry, and establishment of city plan lately. Therefore, recognition of the object in satellite images is important and it is necessary to detect the objects in the satellite images accurately and distribute the information to the institutes.

The satellite images are being processed with image processing techniques. Image processing techniques can be divided into several classes, such as image classification, image segmentation, image enhancement and image compression. Image classification refers to the categorizing of images into one of a number of classes which are predefined. The feature of the satellite image was label into different classes, enable the system to differentiate between different objects. Recognition and classification of the objects in the satellite image were done by comparing the image patterns with the target pattern.

The challenge that faced by the researchers is over-classification or under-classification of the area of classes in the satellite images. It causes failure of classification process and lead to a poor classification result. The similarity between features causes difficulties in differentiating the difference between objects in the satellite image and affected the accuracy in the classification process.

According to the previous research, there are several types of image classification methods to recognize the object in the satellite images, such as Maximum Likelihood in supervised method, ISODATA in unsupervised method. These methods were able to successfully recognize the objects in satellite images and

it was a contribution for the future research and study in this field. In this project, the study was be focused on Maximum Likelihood and ISODATA techniques to identify the best technique for satellite image classification.

## 1.2 Problem Statement

There are a lot of image classification methods to classify the satellite images such as Supervised Classification, Unsupervised Classification and Object-Based Classification. According to the previous research, there are some common techniques that being used to classify the satellite image. One of the supervised classification methods is Maximum Likelihood and ISODATA is one of the unsupervised classification methods.

The ability to classify the pixels of each classes accurately is very important, problems such as overclassify or under-classify may lead to a poor result. One of the challenges in satellite image classification is it may have difficulties in differentiating the difference between objects in the satellite image and not able to classify the objects accurately. Besides, there are a lot of classification methods, different method may give output with different accuracy. The aim of this project is to study and identify the best techniques use to obtain the most accurate classification output. The problem statements are summarized in Table 1.1.

**Table 1.1 Problem Statements**

<b>PS</b>	<b>Problem Statement</b>
<b>PS1</b>	Difficulties in differentiating the difference between objects in the satellite image
<b>PS2</b>	Consists of various techniques in satellite image classification

## 1.3 Project Question

Based on the problems stated in Table 1.1, the project questions are being identified to overcome the problem statements. The project questions are:

1. It is important to identify the techniques that are suitable to classify satellite image with a good output result. Therefore, what classification techniques can be used to classify satellite image?
2. Based on the research conducted by researcher, there are a lot of classification techniques can be used to classify satellite image. It is important to figure out which techniques can be implemented to obtain the best result in differentiating objects in satellite image.
3. Based on the techniques selected, the result will be compared to identify the best output. Hence, it is important to determine which of the proposed technique can give the best output.

The summary of the Problem Statement and Project Questions as describe in Table 1.2.

**Table 1.2 Project Questions**

PS	PQ	Project Question
PS1	PQ1	What classification techniques can be used to classify satellite image?
PS2	PQ2	Which techniques can be implemented to obtain the best result in differentiating objects in satellite image?
PS2	PQ3	Which of the proposed technique can give the best output?

#### 1.4 Project Objective

Based on the problem statements and project questions stated in Table 1.1 and Table 1.2, there are three objectives implemented in this project. The project objectives are:

1. To identify the classification techniques in satellite image classification.
2. To apply Maximum Likelihood and ISODATA techniques for satellite image classification.
3. To evaluate the best technique in satellite image classification.

The summary of the Problem Statement, Project Questions and Project Objectives as describe in Table 1.3.

**Table 1.3 Project Objectives**

PS	PQ	PO	Project Objective
PS1	PQ1	PO1	To identify the classification techniques in satellite image classification.
PS2	PQ2	PO2	To apply Maximum Likelihood and ISODATA techniques for satellite image classification.
PS2	PQ3	PO3	To evaluate the best technique in satellite image classification.

### 1.5 Project Scope

The satellite image of Malacca city in Malaysia was used to conduct the image classification process in this project and the satellite images was downloaded from Google Earth. Google Earth was selected because this platform is free and easy for us to download the image. The image was downloaded on 24/5/2021 and the highest resolution available in Google Earth is 4800 x 2679 pixels.

This project was done by using MATLAB software running on Window platform. MATLAB is chosen because it is one of the most effective software to code and debug program. The satellite image was processed by using one supervised classification method and one unsupervised classification method in MATLAB.

### 1.6 Project Contribution

Image processing is widely used in technology and science's field such as computer vision and remote sensing. The study contributed to the experts in the field of technology and science such as land cover mapping, regional planning and environmental monitoring.

## 1.7 Report Organisation

In this project, there are six chapters to be discussed. The content that discussed in each of the chapter are:

Chapter 1, this chapter explained about the introduction of the project. It also discussed about the problems facing in current situation, the project questions, and the project objectives which needed to be accomplished. Besides, this chapter also explained about the project scope and project contribution of the project.

Chapter 2, this chapter discussed about the literature review, previous research done by the researchers, such as the method used in image classification, and the challenges faced in current situation.

Chapter 3, this chapter explained about the methodology used when conducting this project. The procedures of each of the method were described here.

Chapter 4, this chapter discussed about the implementation of the project. The software and hardware used, and the procedures in conducting the project were clearly stated.

Chapter 5, this chapter explained about the result and analysis of the project. Comparison between the two techniques was carried out to obtain the best result to identify which techniques is more effective for this project.

Chapter 6, this chapter discussed about the conclusion of the project. Project summarization, project contribution, project limitation, and future works were discussed in this chapter.

## 1.8 Conclusion

Satellite images are one of the most important and powerful tools used to collect the photo of Earth. It contains useful information, such as the shape of the river, shape of the road, coverage of the urban area and forest area. There are a lot of techniques can be implemented to classify the satellite image. The techniques that focused in this project is Maximum Likelihood and ISODATA.

There are three objectives in this project, that is to identify the classification techniques in satellite image classification, to apply supervised classification method, Maximum Likelihood and unsupervised classification method, ISODATA for satellite

image classification, and to evaluate the best technique in image classification. The area to be covered in this project is Melaka and the satellite image was downloaded from Google Earth. MATLAB software was used to process the images. At the end of the project, the satellite image was successfully classified using two different techniques, that is Maximum Likelihood and ISODATA. With these image classification techniques, the elements in the satellite image were recognized efficiently and accurately.



## CHAPTER 2

### LITERATURE REVIEW

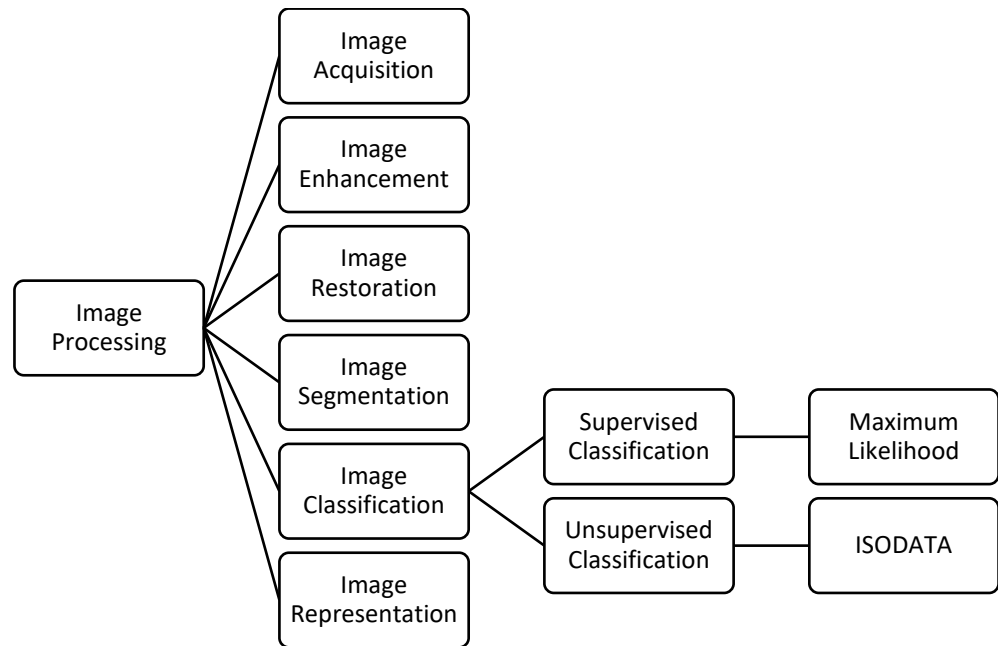
#### 2.1 Introduction

In the field of satellite image classification, there are many technologies being introduced to classify the element in the satellite image. The purpose of classification process is to arrange and sort all pixels in a digital image into one of the classes, and allow the system to recognize the element in the digital image. According to the previous research carried out by the researchers, there are a lot of techniques can be used to classify image, such as Minimum Distance, Maximum Likelihood, Parallelepiped, K-means and ISODATA. However, each of the techniques have both strengths and weaknesses, it is hard to find a technique that is suitable to classify all types of images.

Image classification is the process in computer vision that can classify an image according to its visual content and it is widely used in satellite image classification. There are a few methods can be used to classify the satellite image, and the purpose of this project is to identify the method that can produce a best result in satellite image classification.

#### 2.2 Related Work/Previous Work

In this project, both supervised and unsupervised classification was covered. The two classification techniques to be implemented in this project are Maximum Likelihood and ISODATA. The summary of image processing is as shown in Figure 2.1.



**Figure 2.1 Image Processing Summary**

Image classification can be divided into two categories, that is supervised classification and unsupervised classification. The two methods under supervised and unsupervised classification were discussed and implemented in this project.

### 2.2.1 Image Processing

Image processing is a process to extract useful data from certain image, by performing some operations on that image. It is one of the types of signal processing, and the process can be conducted by using programming languages such as MATLAB, Java or C++. The process of image processing is about input a source of image and get the output in the form of enhanced image, desired characteristic or features of the image by applying some mathematical operation.

There are three phases in image processing, which are use image classification tools to import the image, analyze and manipulate the image, and output is the final step where result can be altered image or report which is based on image analysis. The quality of the processed image remains the same after undergoing image processing steps.