REMOTE SENSING TECHNIQUE FOR OIL PALM AGE CLASSIFICATION USING LANDSAT-5 TM SATELLITE

SHAMALA VADIVELU

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Alamat tetap: Lot 3248, Batu4 ,JalanSekolah , RantauPanjang, 42100 Klang.	DR. CHOO YUN HUOY NamaPenyelia
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SHAMALA VADIVELU

This report is submitted in partial fulfilment of the requirements for the Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2014

DECLARATION

I hereby declare that this project report entitled

REMOTE SENSING TECHNIQUE FOR OIL PALM AGE CLASSIFICATION USING LANDSAT-5 TM SATELLITE

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT :_______________________________________ DATE:________

(SHAMALA VADIVELU)

SUPERVISOR:_______________________________________ DATE:________

(DR CHOO YUN HUOY)

DEDICATION

I dedicate my final year project report to my family and friends. To my supervisor, Dr. Choo Yun Huoy and Dr. Asmala Ahmad, for guiding and helping me to finish up this project. I would like to express deep gratitude to my beloved parents for a life-long love and affection. They have been very supportive and encouraging in completion of my thesis and throughout the years of my studies. On top that, I also would like to dedicate this report to my close friends and family who have been very supportive throughout the project development.

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ABSTRACT

Age of oil palm is an important variable used in carbon and yield forecasting studies. Conventionally, the age classification of oil palm was made manually by mapping the plantation area. This technique is time consuming and difficult to classify a large area of hectare which causes difficulty for organisation like MPOB to analyse on the yield production. With remote sensing, the nature of acquiring the oil palm age through spectral response is more convenient. Limited studies were concerning the performance of current technique in classification of oil palm age. Mostly were using traditional parametric statistical approaches. Moreover, previous studies for vegetation age prediction were carried using different remote sensing approaches consisting of different resolution and measurements of data. This project demonstrates the procedure/algorithm to classify age of oil palm trees using LANDSAT-5 TM remote sensing data. The study were conducted in two phases; where phase I is the land cover classification whereas phase II is the oil palm age classification. Firstly, region of interest (ROI) was identified and drawn in order to supply training and testing pixels for the supervised classification. Maximum likelihood (ML) classifier was used for land cover classification with overall accuracy of 85.69%. Whereas, three classifiers were studied, such as: ML, Neural Network (NN) and Support Vector Machine (SVM) for oil palm age classification. Two sets of training set, smaller training set and larger training set were compared to obtain a good result. The accuracy of the classifications was assessed by using confusion matrix and decision boundary analysis. In conclusion, SVM could be used to classify oil palm age as it performs the best with highest overall accuracy of 91.89%. It is stable of limited amount and quality of training data. Further study can focus on hybrid techniques for age classification with accuracy assessment using ground truth image instead of ROI.

ABSTRAK

Usia kelapa sawit adalah pembolehubah penting yang telah digunakan dalam banyak kajian, seperti dalam kajian karbon dan ramalan hasil. Sebelum ini, pengesanan umur atau pengelasan kelapa sawit telah dibuat secara manual dengan pemetaan kawasan ladang. Teknik ini memakan masa dan sukar untuk organisasi seperti MPOB untuk mengelaskan kebesaran hektar. Dengan „remote sensing", sifat memperoleh umur kelapa sawit melalui tindak balas spektrum adalah lebih mudah. Kurang kajian mengenai prestasi teknik semasa untuk klasifikasi umur kelapa sawit. Kebanyakannya adalah menggunakan pendekatan tradisional statistik parametrik. Selain itu, kajian sebelum ini untuk ramalan umur tumbuhan telah dijalankan menggunakan pendekatan dengan sensor satelit berlainan yang terdiri daripada resolusi dan pengukuran data yang berbeza. Projek ini menunjukkan prosedur / algoritma untuk mengklasifikasikan umur pokok kelapa sawit menggunakan LANDSAT-5 TM data. LANDSAT-5 TM adalah sensor yang merekodkan dalam 7 band spektrum. Kajian ini telah dijalankan dalam dua fasa; di mana fasa I adalah klasifikasi kawasan manakala fasa II adalah klasifikasi umur kelapa sawit. Pertama,kawasan telah dikenalpasti untuk membekalkan "training" dan "testing" piksel. ML merekod hasil yang cukup baik dengan ketepatan keseluruhan 85.69% . Manakala, tiga kaedah klasifikasi, seperti: ML, NN dan SVM digunakan untuk pengelasan umur kelapa sawit. Dua set set latihan, set latihan yang lebih kecil dan set latihan lebih besar dibandingkan untuk mendapatkan hasil yang baik. Ketepatan pengelasan dinilai dengan menggunakan matriks kekeliruan dan analisis sempadan keputusan. Kesimpulannya, SVM boleh digunakan untuk mengelaskan umur kelapa sawit dimana ketepatannya adalah yang tertinggi iaitu 91.89%. Ia boleh klasifikasi dengan jumlah dan kualiti data latihan yang terhad. Kajian lanjut boleh memberi tumpuan kepada teknik-teknik hibrid untuk pengelasan umur dengan penilaian ketepatan menggunakan imej kebenaran tanah dan bukan ROI.

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DMC	-Disaster Management Constellation
ENVI	-Environment for Visualizing Images
LAI	-Leaf Area Index
MCI	-Multi-Coefficient Image
ML	-Maximum Likelihood
AVHRR	-Advanced Very High Resolution Radiometer
MODIS	-Moderate-resolution Imaging Spectroradiometer
NN	-Neural Network
OBIA	-Object-Based Image Analysis
SVM	-Support Vector Machine
TM	-Thematic Mapper
MPOB	-Malaysian Palm Oil Board

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CHAPTER I

INTRODUCTION

1.1 Project Background

Satellite remote sensing data constitute a significant potential source of information on our environment, provided they can be adequately interpreted. Remote sensing is the observations and measurement of objects from a distance where objects or the recorders are not in contact under investigation. Remote sensing is one of the technologies used in image processing. Certain physical properties of objects are determined by remote sensing through the measurement of some kind of energy that is emitted; transmitted, or reflected from an object. Remote sensing has been used in many fields such as vegetation, meteorological analysis, inspection and prevention of geological disaster and military purposes. According to study by Bacour, vegetation has a major influence on the exchange of energy between the atmosphere and the earth"s surface as it is fundamental element of earth surface (Bacour et al.2002). Remote sensing has been recognized as a reliable method for prediction of various biophysical and biochemical vegetation variables (Cohen et al. 2003). First report of remote sensing being implemented in agricultural management, although indirectly used, begun with the mapping of soil resources from aerial photography in 1929 by Kellogg. Remote sensing was possible for oil palm plantation with the improving in the quality and availability of remote sensing as oil palm has become the most important commodity crop in Malaysia .Based on an article by UNEP Global Environmental Alert Service (GEAS), in Asian region, Malaysia and Indonesia, records the highest production where 85 per cent of global production of oil palm takes place there. 45% of the world‟s oil palm production is by Malaysia and it exports 80% of its total production. Malaysia is being under large scale plantation system operating as a nucleus of many smallholder producers (Butler, et al., 2009). Conventionally, the age detection or classification was made manually by mapping the plantation area. From my ground survey on 28th March, according to the plantation officer, they keep track of the plantation age by mapping up the plantation area manually. He did mentioned that this manually method sometimes cause inaccurate due to carelessness in data interpretation by the workers. This file system wasn‟t systematic and may cause loss of the data. Besides that, acquisition of information on a large area of oil palm plantation are also difficult and time consuming if the data are kept manually as the whole area might be owned by various plantation owners. With remote sensing technology, the nature of acquiring the oil palm age through spectral response is more convenient.

The economic vitality of oil palm crop requires accurate and timely of its agronomy for best management strategy. Fruit bunches which are harvested from oil palm trees being used to produce palm oil. One of the important factor of fruit bunches production is the age. Oil palm starts its production at the age of two years old. Its optimum production is at the age of six to ten years after planting. Age of oil palm is an important variable which has been used in many studies, like in carbon study and yield forecasting. In terms of carbon study, age is a variable in algometric equation for estimating oil palm biomass and carbon stocks. Oil palms also produce twice more oil than rape seed and almost four times more than soy beans, groundnut and sunflower per hectare per year (Tan, et al., 2009). Therefore, age prediction using remote sensing is seen to be vital. Usage of remote sensing could actually be useful for some of the parties such as Malaysian Palm Oil Board (MPOB) in term of prediction of annual yield as age of the oil palm highly correlate with the yield production. The data used in this study is satellite data. The satellite data come from several bands (multispectral) of Landsat-5 TM (Thematic Mapper).Images from these high resolution satellites can have 1m or sub meter pixel resolutions.

1.2 Problem Statement

The study of age classification using remote sensing technology offers a new alternative way over the conventional methods practised elsewhere. Vegetation age has commonly used in study of yield production, carbon stocks and monitoring of yields. The mapping and monitoring of vegetation biochemical and biophysical variables is important for spatially distributed modelling of vegetation productivity, evapotranspiration, and surface energy balance. Measurements of this feature of vegetation manually would be labor-intensive and costly, so it is practical on experimental plots using remote sensing. Conventionally, the age classification of oil palm was made manually by mapping the plantation area. This technique is time consuming and difficult to classify a large area of hectare which causes difficulty for organisation like MPOB to analyse on the yield production. Nature of acquiring the oil palm age through spectral response is more convenient. The study on the relationship of spectral measurements from LANDSAT 5 TM data with oil palm age is a little shallow. LANDSAT 5 TM is being used due to its capability of capturing spectral wavelengths sensitive to vegetation such as band 2, band 3 and band 4. Images from this high resolution satellite can have 1m or sub meter pixels resolutions. Limited studies were concerning the performance of current technique in classification of oil palm age. Mostly were using traditional parametric statistical approaches. Furthermore, the existing techniques are also being studied on different satellite sensors consisting of different resolution and measurements of data. Thus, the aim of this study is to compare the relationship of spectral measurements from Landsat-5 TM satellite data with oil palm age and develop procedure for vegetation classification. The study is also to propose a technique for oil palm age classification. This study will be helpful for some of the organizational boards to decide the actions to remedy low yield regions as one could predict the yield that supposed to obtain for a particular age.

1.3 Objective

In order to achieve aim of the study, the study embarks on the following objectives:

1. To compare the spectral measurements from satellite for oil palm age classification.
2. To propose a procedure for vegetation extraction and classification.
3. To propose a techniques for oil palm age classification using a LANDSAT-5 TM satellite data.
4. To verify the results, analyse and make accuracy assessment of the produced result.

1.4 Scopes

The scope of the study is divided into four parts: software scope, data scope, area of study scope and user scope.

1.4.1 Software Scope

Mainly, there are two software tools being used in this study. Firstly is the ENVI 4.5 toolbox which is used to process and analyse the image of LANDSAT-5 TM satellite data while the second would be MATHLAB R2010a for representing and analysing decision boundary.

1.4.2 Data Scope

The data that is used for this study is a **Landsat 5 Thematic Mapper** (TM) satellite data dated on 22nd August 2005. Landsat 5 TM was a low Earth orbit