



SATELLITE IMAGE SEGMENTATION USING THRESHOLDING TECHNIQUE

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in fulfillment of the requirements for the degree of Master of Computer
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2017

DECLARATION

I declare that this dissertation entitle “Satellite Image Segmentation Using Thresholding Technique” is the result of my own research except as cited in the references. The dissertation has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this dissertation and in my opinion this dissertation is sufficient in terms of scope and quality for the award of Master of Computer Science.

Signature :

Supervisor Name :

Date :

DEDICATION

First and foremost, I would like to thank ALLAH Almighty, for giving me excellence health, ideas and comfort environment so that I can complete this dissertation as scheduled.

My greatest thank is to my parents (Haji Khalik bin Haji Samat and Hajjah Salmiyah binti Haji Surif), my wife (Norhazlina binti Mohamad), my daughters (Damia Hamani and Durrah Inarah) and my siblings (Noor Haffizah, Nur Syahidah, Nur Syamilah and Nur Hasanah) for their continuous understanding, motivation, encouragement and patience throughout my Master project journey.

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ABSTRACT

Image segmentation is one of the basic techniques of image processing and computer vision. It is a key step for image analysis, comprehension and description. Among all the segmentation techniques, thresholding segmentation method is the most popular algorithm and is widely used in the image segmentation field. The basic idea of automatic thresholding is to automatically select an optimal or several optimal grey-level threshold values for separating objects of interest in an image from the background based on their grey-level distribution. Image segmentation techniques were widely used in image analysis for various areas such as biomedical imaging, intelligent transportation systems and satellite imaging. A major challenge for image segmentation is to segment the complex images with noise, intensity inhomogeneity, texture or multiphase structure. However the main issue in remote sensing is image classification that required determining an appropriate threshold between species in producing accurate segmentation image. Image segmentation on satellite imagery is a complex process and requires consideration of accurate classification system. A pixel in the satellite image may possibly cover more than one object on the ground. A threshold has to be set to classify an overlap of two or more associated spectral properties. Therefore the aim of this study is to determine the optimal threshold value for object classes to ensure the misclassification of image pixels kept as low as possible by analyzing the classification of satellite images at different hierarchical level. Then the optimal threshold value will be proposed on satellite image segmentation for Universiti Teknikal Malaysia, Melaka (UTeM) area. An evaluation on the accuracy of the enhanced threshold value in identifying and classifying the urban objects shall be made. A hierarchical threshold is expected to significant improvement result on an image segmentation final image for UTeM area.

ABSTRAK

Imej segmentasi adalah salah satu daripada teknik-teknik asas pemprosesan imej dan visi komputer. Ia merupakan satu langkah utama untuk analisis imej, kefahaman dan penerangan. Di antara semua teknik segmentasi, cara ambang 'threshold' segmentasi adalah algoritma yang paling popular dan digunakan secara meluas dalam bidang imej segmentasi. Idea asas pengambangan automatik adalah untuk memilih nilai ambang kelabu- tahap optimum atau lebih secara automatik untuk memisahkan objek kepentingan dalam imej daripada latar belakang berdasarkan pengagihan kelabu- tahap mereka. Teknik segmentasi imej telah digunakan secara meluas dalam analisis imej untuk pelbagai bidang seperti pengimejan bioperubatan, sistem pengangkutan pintar dan pengimejan satelit. Cabaran utama bagi segmentasi imej adalah untuk segmen imej kompleks dengan bunyi, keamatan ketakhomogenan, tekstur atau struktur berbilang. Walau bagaimanapun, isu utama dalam penderiaan jauh adalah klasifikasi imej yang diperlukan menentukan ambang yang sesuai antara spesies dalam menghasilkan imej segmentasi tepat. Segmentasi imej pada imej satelit adalah satu proses yang kompleks dan memerlukan pertimbangan sistem klasifikasi tepat. Piksel dalam imej satelit yang mungkin boleh meliputi lebih daripada satu objek di atas tanah. Ambang perlu ditetapkan untuk mengklasifikasikan pertindihan dua atau lebih ciri-ciri spektrum yang berkaitan. Oleh itu tujuan kajian ini adalah untuk menentukan nilai ambang optimum untuk kelas objek untuk memastikan misclassification piksel imej disimpan serendah yang mungkin dengan menganalisis pengelasan imej satelit di peringkat hierarki yang berbeza. Maka nilai ambang optimum akan dicadangkan pada segmentasi imej satelit untuk Universiti Teknikal Malaysia (UTeM) Melaka. Penilaian kepada ketepatan nilai ambang yang dicadangkan dalam mengenal pasti dan mengelaskan objek bandar perlu dibuat. Ambang hierarki dijangka hasil peningkatan yang ketara pada imej akhir imej segmentasi bagi kawasan UTeM.

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| E | Display RGB Code |

LIST OF ABBREVIATIONS

| | | |
|----|---|----------------|
| DN | - | Digital Number |
| R | - | Red Band |
| G | - | Green Band |
| B | - | Blue Band |
| m | - | Meter |

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CHAPTER 1

INTRODUCTION

1.1 Background

Image processing is a technique or formula to resolve an image into a digital form and implement some operations on it, in order to get a better and enhanced image or to derive some valuable data, material and information from it (Sathya and Malathi 2011). It is a type of signal dispensation in which input is image, like video frame or photograph and the output maybe image or characteristic associated with that image. It was distributing into several parts which include image compression, image segmentation and image classification and so on.

In computer perception, image segmentation is the process of dividing a digital image into multiple segments (sets of pixels, also known as super pixels)(Quan Zhou, Canxiang Yan, Yingying Zhu 2011). The goal of segmentation is to convert or adapt the description of an image into something that is more significant and easier to study. Image segmentation is basically used to place entities and boundaries such as tracks, arcs, curves, etc. in images. More accurately, image segmentation is the cognitive operation of appointing a label or mark to every pixel in an image such that pixels with the same label allot and accord certain attributes(Chen Hejun, Ding Haiqiang, He Xiongxiang* 2014).

Nowadays, image segmentation techniques are being widely used in the medical, military and information science fields such as magnetic resonance image (MRI) and

remote sensing (Rao 2006). It shows that image segmentation plays an authoritative and influential role in enhancing human's quality of life. A various general-purpose algorithms and approaches have been formulated for image segmentation. To be beneficial, these approaches must normally be incorporated with a field's special understanding and wisdom in order to adequately solve the domain's segmentation issues.

The easiest approach of image segmentation is known as the thresholding technique (Duncan 1990). This technique is established on a threshold value (or a clip-level) to twirl a gray-scale image into a binary image. There is even, an equivalence histogram edge and verge (Jassim 2012). The fundamental of this approach is to appoint the threshold value (or values while multiple-levels are chosen). A various popular methods are applied in business, work and industry comprising the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Besides that, there are various methods of thresholding such as global thresholding, single thresholding, double thresholding, and moving averages (Gonzalez, Woods, and Eddins 2004).

The satellite photograph comprises enormous quantity of information and knowledge for analytic thinking and refinement. But human eye is insensible to recognize slender adaptations in the features such as vividness, color, and/or grain. So the instructions of human preparation is not effective to recoup the obscure fortunes of information in the satellite photograph (Ganesan et al. 2015).

Satellite images frequently involve segmentation in the appearance of doubtfulness, caused due to factors like environmental conditions, bad resolution and fault illumination. Since any consequent image analysis relies on the quality of such segmentation, one has to accomplish a practical algorithm for the purpose. Pixel clustering is a prevalent way of deciding the similar and homogeneous image areas, according to the dissimilar land cover types, founded on their apparitional assets (Mitra and Kundu 2011).

1.2 Research Problem

Image segmentation role is very important in today's society. It is no longer a new image processing technology used to divide the pixels in the image. It is also a new solution to the various problems related to human health, military and security of a country. Therefore, the right and accurate segment of image is expected to help human to control and use the appropriate application in the required fields.

However, to justify and determine a specific techniques to be applied on a certain image are not easy. Hence a few research problems are listed as shown in Table 1.1.

Table 1.1: Summary of Problem Statement

| RP | Research Problem |
|-----|--|
| RP1 | Difficulty to identify a single technique that can solve many problems especially for satellite image. |
| RP2 | Difficulty to determine an optimal threshold value for satellite image segmentation. |
| RP3 | Difficulty to adjudge the performance/ fidelity of the image segmentation technique. |

From the above research problem statements in Table 1.1, three research problems are conducted to be identified. The detail description for each of the Research Problems (RP) is explained as follows:

RP1: Difficulty to identify a single technique that can solve many problems especially for satellite image.

Image segmentation has developed a variety of techniques through the use of a specific algorithm. It evolved and developed with the incorporation of techniques in threshold technique itself or using additional methods in other techniques such as edge detection technique. Hence, various methods have in trying to get the results to be achieved. However, it is quite hard to acquire a method that can solve all the problems in segmentation.

RP2: Difficulty to determine an optimum threshold value for satellite image segmentation.

Optimal value can be defined as the lowest or highest value of the objective subprogram over the attainable area of an optimization problem. It is a value that is somewhat difficult to determine. This is due to the expected output from the resulting techniques used. Although there are differences in the techniques used, however, the difference obtained is too small. Therefore, a more careful observation needs to be done to ensure that the output is as expected.

RP3: Difficulty to adjudge the performance/ fidelity of the image segmentation technique.

This research method is conducted to evaluate the goodness of the chosen technique compared to the results obtained. However, a demand for accurate and automatic segmentation on urban topology has arisen especially for ecological, environmental and economical values.

The main issues of image segmentations for remote sensing are to determine appropriate thresholding techniques, to improve the threshold value of urban topology and to produce accurate segmentation map. Therefore, in order to overcome these issues, more precise information on urban area inventories is required. It includes the determination an appropriate techniques, resolution of satellite image preferred (spectral and spatial), selection of right training samples, image pre-processing and the information of ground data collection.

Thresholding is an act of dividing pixels in the images into object and surroundings division founded on the association between enthusiasm level degrees of the pixel. However the main problem in threshold is to find the correct or optimised threshold value to disjoin an image into admirable foreground and background, hence the misallocation of image pixels is equatorial as low as possible. A good classification map requires accurate threshold value to improve classification accuracy. Therefore there is a need to integrate with two or more segmentation techniques rather than single segmentation technique (D. Lu and Weng, 2007; Huang and Lees, 2004; Steele, 2001).

The research problem has been divided into four sub problem statement are described as below:

- i. Image classification of satellite imagery is a complex process and requires consideration a suitable classification techniques.
- ii. The new conceptual satellite image framework is needed as a guideline to utilized multi-resolution and multi-sources remote sensing products.
- iii. In the satellite image, one pixel is perhaps substitute more than one object on the yard. However, there is a problem on recognizing or classifying a detail geographical thing due to unavailable overspreading of two or more associated spectral lot.