

EARLY DETECTION OF HIGH WATER
SATURATION SPOTS FOR LANDSLIDE
PREDICTION USING THERMAL IMAGE
ANALYSIS

AUFA HUDA BT MUHAMMAD ZIN

Master of Science

UNIVERSITI MALAYSIA PAHANG



SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

(Supervisor's Signature)

Full Name : PROF. IR. DR KAMARUL HAWARI BIN GHAZALI
Position : DEAN OF FACULTY ELECTRICAL & ELECTRONIC
ENGINEERING
Date : 13 JULY 2018



STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : AUFA HUDA BT MUHAMMAD ZIN

ID Number : MEL 14006

Date : 13 JULY 2018

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LIST OF SYMBOLS

F	Set of all pixels
S	Subsets
Σ	Summation
μ_i	Centroid
\emptyset	Null set
\cap	Intersection
$\sqrt{\quad}$	Square root

LIST OF ABBREVIATIONS

ASIFT	Affine SIFT
DAS	Driver Assistance Systems
GIS	Geo Information System
GPS	Global Positioning System
HSV	Hue, Saturation, Value
InSAR	Interferometric Synthetic Aperture Radar
JKR	Public Work Department of Malaysia
JPEG	Joint Photographic Experts Group
MRI	Magnetic Resonance Imaging
OTDR	Optical Time Domain Reflectometry
SIFT	Scale Invariant Feature Transform
SURF	Speeded Up Robust Features
UWB	Ultra Wideband
WSN	Wireless Sensor Network

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ABSTRAK

Media elektronik dan surat khabar sering membincangkan mengenai bahaya tanah runtuh. Disebabkan masalah ini, kerajaan telah menanggung jutaan ringgit Malaysia untuk memperbaiki infrastruktur dan utiliti yang rosak dan juga memberi pampasan kepada mangsa-mangsa yang terlibat. Jadi, sistem amaran awal bagi mengesan tanah runtuh diperkenalkan. Ia merupakan salah satu cara yang berkesan untuk mengurangkan kerosakan yang disebabkan tanah runtuh. Berdasarkan kajian yang dijumpai, terdapat banyak kaedah konvensional untuk meramal tanah runtuh telah dilakukan sebelum ini seperti *remote sensing*, rangkaian sensor tanpa wayar dan banyak lagi. Pada asasnya, tanah runtuh berlaku disebabkan beberapa faktor seperti faktor kecerunan, luluhawa geologi dan aktiviti berkaitan manusia seperti penebangan hutan. Faktor utama tanah runtuh adalah air tepu yang disebabkan oleh hujan lebat. Namun begitu, mata kasar manusia tidak dapat melihat air yang tepu di dalam tanah. Oleh itu, untuk menyelesaikan isu ini, kajian ini merupakan kaedah baru untuk mengesan tempat ketepuan air menggunakan kamera terma untuk pengesanan awal tanah runtuh. Kamera termal dipilih kerana ia membuat ramalan yang tepat tentang lokasi kejadian tanah runtuh itu berlaku. Namun begitu, ia masih memerlukan perisian pemprosesan imej dilakukan terhadap imej tanah runtuh tersebut. Pengimejan terma adalah satu teknik yang menukarkan sinaran yang tidak kelihatan kepada imej yang boleh dilihat untuk dianalisis dan pengekstrakan ciri. Imej-imej akan diproses menggunakan perisian pemprosesan imej. Tahap kecekapan perisian pemprosesan imej diukur berdasarkan bagaimana kawasan yang penting pengesanan untuk menghapuskan piksel yang tidak diinginkan daripada imej dilakukan. Beberapa algoritma segmentasi telah digunakan di dalam kajian ini iaitu HSV, K-Means dan Feature Matching. Hasil menunjukkan bahawa teknik HSV adalah segmentasi yang terbaik dengan purata ralat bersamaan dengan 0.00165 untuk imej yang tidak normal, 0.0061 untuk imej biasa dan 0.0014 untuk kombinasi imej yang tidak normal dan biasa. Tambahan pula, kaedah ramalan perlu membuat keputusan dan mengklasifikasikan imej ke dalam kumpulan yang betul. Oleh itu, selepas kawasan yang penting yang telah dikesan, ciri pengekstrakan dan klasifikasi mesti dilakukan. Statistik berdasarkan dipaparkan iaitu minimum, maksimum, purata dan sisihan piawai ini diekstrak daripada setiap imej. Keputusan menunjukkan klasifikasi menggunakan *linear thresholding* telah berjaya memasukkan imej ke dalam kumpulan yang betul.

ABSTRACT

Landslide hazard is often discussed in electronic media and newspapers. Due to this problem, the government needs to bear millions of Malaysian ringgit to repair the infrastructures and utilities that had been ruined and to compensate the victims involved. Early warning system is one of the effective ways to reduce damage caused by landslides. Based on the literature found, there are many conventional methods to predict landslide that had been used previously such as remote sensing, wireless sensor network and many more. Basically, landslides happen due the many factors such as slope gradient factor, geological weathering and human-related activities such as deforestation. The main factor for landslide is water saturation, caused by heavy rain. Our naked eyes cannot see the water saturation in the soil. Hence, to solve this issue, this study investigates a new method to detect water saturation spots which is integrated with a thermal image camera to provide early detection of landslide. Thermal camera is selected because it provides accurate predictions on where landslides could occur. Thermal imaging is a technique that converts the invisible radiation into visible image for analysis and feature extraction. The images are processed using image processing software. Performance of image processing software is based on how accurate Region of Interest (ROI) detection is to eliminate unwanted pixels from an image. There are three segmentation algorithm used in this study which are HSV, K-Means and Feature Matching. The result reveals that HSV color space technique provides the best segmentation with average misclassification error equals to 0.00165 for abnormal images, 0.0061 for normal images and 0.0014 for combination of abnormal and normal images. Furthermore, the prediction method should make decision and classify the images into correct groups. Therefore, after the ROI has been detected, feature extraction and classification must be performed. Statistical based features namely minimum, maximum, mean and standard deviation were extracted from each image channels. The results show that the classifications using linear thresholding had sorted the image into correct group successfully.

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