



**UNIVERSITI PUTRA MALAYSIA**

**DEVELOPMENT OF AN AUTOMATED TECHNIQUE FOR  
RECONSTRUCTING JAWI CHARACTERS IN HISTORICAL  
DOCUMENTS**

**TENGGU MOHD AFENDI ZULCAFFLE**

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**MASTER OF SCIENCE  
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**2007**





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**By**

**TENGGU MOHD AFENDI ZULCAFFLE**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia  
in Fulfilment of the Requirements for the Degree of Master of Science**

**March 2007**



*Dedicated*  
*To*  
*My Parents*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
fulfilment of the requirement for the degree of Master of Science

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**Chairman : Mohammad Hamiruce Marhaban, PhD**

**Institute : Institute of Advanced Technology**

The old documents in Jawi script are still being used widely for references. The quality of the hard copies of those scripts will be deteriorating as time passes. Manual reconstruction may take long time if the documents are sufficiently thick. The accuracy of the document image recognition algorithms is much dependent on the level of noise on the document. Therefore, the development of the historical Jawi character reconstruction algorithm is a significant contributions to the success of the old Jawi manuscript maintenance and recognition systems.

The Background Subtraction technique has proved to be the best algorithm when historical document images were evaluated. The proposed technique has improved the algorithm by incorporating an autonomous decision making, that makes the binarization technique a scale invariant algorithm.



The prefiltering and post processing will further enhance the ability of the algorithm to remove noise from the documents. In the post binarization algorithm, separation techniques between characters with holes and without holes is introduced in order for different morphological operations to be applied to those characters. This method will enhance connection between broken characters but still preserving the originality of the document. A noise model has been developed to test the reliability of the proposed algorithm. The model was developed based on several predefined criteria. The algorithms have been implemented using Matlab software version 6.5.

The reliability of the proposed algorithms have been tested over simulated and real data. Comparison has been made between the Background Subtraction technique and the proposed method by manual inspection and mathematical evaluation. The results of the algorithms were mathematically evaluated using the Relative Foreground Area Error. Results have shown that better performance has been obtained using the proposed method. The framework managed to create historical Jawi characters more presentable. The system is not only applicable to historical Jawi characters, it can be easily adapted to any other historical characters in different languages.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Master Sains

**PEMBANGUNAN TEKNIK AUTOMATIK UNTUK PEMBINAAN  
SEMULA AKSARA JAWI DI DALAM DOKUMEN BERSEJARAH**

Oleh

**TENGGU MOHD AFENDI ZULCAFFLE**

**Mac 2007**

**Pengerusi : Mohammad Hamiruce Marhaban, PhD**

**Institut : Institut Teknologi Maju**

Dokumen lama dalam skrip Jawi masih digunakan secara meluas untuk rujukan. Kualiti salinan asal skrip tersebut akan menyusut bila masa berlalu. Pembinaan semula secara manual akan mengambil masa yang lama sekiranya dokumen tersebut adalah tebal. Ketepatan algoritma pengecaman imej dokumen adalah sangat bergantung kepada tahap hingar pada dokumen tersebut. Maka, pembangunan pembinaan semula aksara Jawi bersejarah adalah suatu sumbangan kepada kejayaan sistem penyelenggaraan dan pengecaman manuskrip Jawi lama.

Teknik Penolakan Latarbelakang telah dibuktikan sebagai algoritma terbaik bila imej dokumen bersejarah dinilai. Teknik yang dicadangkan telah menambahbaik algoritma tersebut dengan menyelitkan pembuat keputusan secara automatik menyebabkan teknik perdua suatu algoritma tidak ubah



skala. Pra penapis dan pemprosesan susulan akan menambah tingkatan keupayaan algoritma untuk menyingkirkan hingar daripada dokumen. Dalam algoritma perduaan susulan, teknik pemisahan antara aksara-aksara dengan lubang and tiada lubang diperkenalkan supaya operasi morfologi berbeza digunakan untuk aksara-aksara tersebut. Kaedah ini akan menambahbaikkan sambungan antara aksara-aksara yang pecah tetapi masih mengekalkan keaslian dokumen. Model hingar telah dibangunkan untuk menguji kebolehpayaan algoritma yang dicadangkan. Program-program telah dibangunkan menggunakan perisian Matlab versi 6.5 sebagai bahasa pengaturcaraan.

Kebolehpayaan algoritma yang dicadangkan telah diuji ke atas data-data simulasi dan sebenar. Perbandingan telah dibuat antara teknik Penolakan Latarbelakang dan kaedah yang dicadangkan dengan pemeriksaan manual dan penilaian secara matematik. Hasil algoritma tersebut dinilai secara matematik menggunakan Ralat Kawasan Latarhadapan Relatif. Hasilnya menunjukkan prestasi yang lebih baik telah diperolehi dengan menggunakan kaedah yang dicadangkan. Rangka kerja ini telah berjaya membuatkan character Jawi bersejarah lebih baik rupanya. Sistem ini tidak hanya boleh diaplikasikan kepada aksara Jawi bersejarah, ianya mudah diubahsuai kepada sebarang aksara bersejarah dalam bahasa yang lain.

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I certify that an Examination Committee has met on 8<sup>th</sup> March 2007 to conduct the final examination of Tengku Mohd Afendi Zulcaffle on his Master of Science thesis entitled “Automated Historical Jawi Characters Reconstruction Technique” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the 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 UPM or other institutions.

---

**TENGGU MOHD AFENDI ZULCAFFLE**

Date: 23 APRIL 2007

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## LIST OF ABBREVIATIONS

HADMA	Hadamard Mutliresolution Analysis
NIR	Native Integral Ratio
QIR	Quadratic Integral Ratio
DTA	Dynamic Thresholding Algorithm
IFA	Integrated Function Algorithm
DoG	Differential of Gaussian
ROIs	Regions of Interest
LoG	Laplacian of Gaussian
HJTRNM	Historical Jawi Text Region Noise Model
AHJCRT	Automated Historical Jawi Character Reconstruction Technique
MLoG	Matlab version of Laplacian of Gaussian
BS	Background Subtraction
ITBR	Iterative Thresholding with Background Removal
PITBR	Prefiltered Iterative Thresholding with Background Removal
RAE	Relative Foreground Area Error





# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Over the past decades, with the advancements of computer technology, digital computational techniques, and image processing technology which deals with one of the major information sources of human being, have experienced tremendous development. Availability of electronic imaging tools and effective image processing makes it feasible to enhance degraded images. Many algorithms have been developed to improve degraded historical document images. Those algorithms can be categorized into parametric and nonparametric.

The Jawi script is an art of writing that has been existed for centuries in the South East Asia. Its existence is directly related to the dawn of Islam to the South East Asia. The Jawi script is originated from Arabic script. The script has been adapted to suit Malay Language system. The Jawi alphabets and its differences with the Arabic script is shown in Figure 1.1. The figure shows the Jawi script with the circled alphabets are unique to Malay language and cannot be found in Arabic script. The Jawi script had been widely used in every aspect of life since the age of Pasai Islamic Government and later to the age of Malacca Empire and also to the age of Aceh Government on the 17<sup>th</sup> century. The prove of Jawi script existence in Malaysia is when the Batu Bersurat Terengganu was found dated 702H or 1303AD (Hashim,