STROKE-TO-STROKE MATCHING IN ON-LINE SIGNATURE VERIFICATION

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ABSTRACT

On-line Signature Verification is a field of verifying the time series signature data that normally obtained from the tablet-based device. Unlike common signature image, the on-line signature image data consists of points that are arranged in sequence based on time. The aim of this research is to develop a new approach to map the strokes in both test and reference signatures as well as to verify the originality of the test signatures. Current methods make use of the DTW algorithm and its variant to segment them before comparing each of its data dimension. This project suggesting a modified DTW algorithm with the proposed Missed Nodes Recovery Algorithm aims to improve the mapping performance, hence the development of stroke to stroke signature comparison is possible. This project is also proposing a method to compare the strokes with its similar strokes in on-line signature. All algorithm and experiments will be carried out using Matlab. The output of this research project is an algorithm that can be used to map strokes as well as to compare similarity of strokes in on-line signature.

ABSTRAK

Pengesahan Tandatangan Atas-Talian adalah merupakan satu kaedah pengesahan data tandatangan urutan masa yang pada kebiasaannya didapati dari alat-alat jenis sentuhan. Data tandatangan jenis ini berbeza dengan data tandatangan biasa disebabkan ianya terdiri dari titik-titik yang disusun mengikut urutan masa. Tujuan kajian ini adalah untuk membangunkan satu kaedah baru agar garisan-garisan dalam tandatangan jenis ini dapat dinilai persamaannya. Dengan itu, keaslian sesebuah tandatangan itu dapat dipastikan. Buat masa ini, algoritma berasas DTW digunakan untuk membahagi-bahagikan tandatangan tersebut sebelum persamaan data setiap dimensi dapat dinilai. Kajian ini pula mencadangkan pengunaan Algoritma Pengembalian Titik yang Terlepas agar prestasi pemetaan tandatangan sekarang dapat ditingkatkan. Ini membolehkan pembangunan satu kaedah yang dapat mengukur persamaan garisan-garisan tersebut. Kajian ini juga mencadangkan satu kaedah yang boleh digunakan untuk mengukur perbezaan antara garisan dalam tandatangan jenis atas-talian ini. Keseluruhan ujikaji dan percubaan algoritma dalam kajian ini menggunakan perisian Matlab. Hasil kajian ini pula adalah merupakan satu algoritma yang boleh digunakan untuk memeta garisan-garisan tandatangan atas-talian dan juga menilai persamaannya.

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LIST OF ABBREVIATIONS

BMS	-	Best Matching Signature
DNA	-	Deoxyribonucleic acid
DP	-	Dynamic Programming
DTW	-	Dynamic Time Warping
EER	-	Equal Error Rate
FAR	-	False Acceptance Rate
FRR	-	False Rejection Rate
RMSD	-	Root Mean Square Distance
RMSE	-	Root Mean Square Error
SVC2004	-	Signature Verification Competition 2004

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Signing a letter with a unique signature is a common practice since a very long time ago as a way of identity verification. It is still until today that signatures are socially accepted as identity verifier (Fairhurst, M. C., 1998). Modern days financial institutions for example, still accept the idea that signature is a valid mode of authentication in cheques. Our legal system also requires handwritten signatures on contracts or legal documents to validate the documents. Having said all these, they show that, handwritten signatures have been accepted and still widely accepted as valid identity verification.

However, with the rapid modernization of the world, verification of identity has become more and more challenging. Signatures are no longer considered safe identity verifications. Nowadays, there are a lot of fraud cases involving fraud signatures on cheques and credit cards (Edge, M.E and Sampaio, R.F., 2009). That

leads to a tighter identity verification system. A reliable identity verification system must ensure that only the identity owner could presents such prove of identity.

Besides signatures, fingerprints are also widely accepted and have been used for quite some time. However, with the evolution of biometrics technology, there are many other types of identity verifications. These newly found type of identity verifications are believed safer than older type of biometrics identification due to the nature of the older ones. Fingerprint for example, according to Roberts, C. (2007) is a form of stamp from physical texture of fingers which could be easily imitated by reconstructing synthetic fingers with fingerprints.

There are also many types of identities in the field of biometrics. Among others are face, fingerprint, palm, iris, DNA, signature and voice (Huang, K. and Yan, H., 1998). The more modern identities like iris and DNA are considered a lot saver than the older ones. However, due to the reasons discussed earlier, signatures are still socially accepted (Fairhurst, M. C., 1998). So, due to this social behavior, the challenge is not only about changing to a new method of identity verification but to make the currently accepted way of identity verification as safe as possible as well.

The motivation to make signature as safe identity verifier has brought many researchers to this field of study. Nowadays, new approach on applying signature has been developed. On-line signature is one example of modernized way of applying signature to make it safer yet maintaining it as a relevant identity verifier in these modern days.

1.2 Problem background

For signatures to continually be accepted as a modern identity verifier, just like thumbprints and palm prints to name a few, a system that could verify the originality of a signature should be developed. However, to date, no algorithm has been developed that are able to fully authenticate handwritten signatures. One of the factors that make signature verification a challenging field is the dynamic behavior of the signature itself. Unlike fingerprint for instance, it is merely impossible to get two genuine signatures that are geometrically similar. For that, researchers are now still looking for features with less dynamic behavior that could represent a signature. As researches continue in this field, the capability of signature verification algorithm improves.

As a benchmark, a standard index had been widely agreed in comparing the performance of signature verification algorithms. Their performance is normally represented by *False Rejection Rate (FRR)* and *False Acceptance Rate (FAR)* where,

FRR = percentage of false rejection from the test set
FAR = percentage of false acceptance from the test set

For decades, FRR and FAR have been used as performance index in signature verifier. Table 1.1 shows performance of some signature verifier.

Table 1.1: FRR and FAR (* for EER)

Year	Method	FRR (%)	FAR (%)
1996	DTW	3.3*	3.3*
1997	DP Optimization	1.6*	1.6*
2003	Variable Length Segmentation / HMM	12	4
2004	Geometric Extrema	0.98*	0.98*
2007	Segment-to-Segment	6.02	6.02
2007	Time Frequency	2.66	1.33
2008	on-line Parameters	1.33	0

There are many researchers use *Equal Error Rate (EER)* instead of *FRR* and *FAR* to represent their algorithm performance. *EER* is the point at which *FRR* and *FAR* are equal and most believe that it represents the performance of the algorithm better.

1.3 Problem Statement

Over the years, there are many techniques and approaches in signature verification. More and more techniques are developed on getting a lower FRR and FAR. One of the common ways nowadays is by matching between segments. The biggest challenge of segment-to-segment matching according to J.Zhang et al. (2007) and J.Lee et al. (2003) is time-alignment. If the timing of a genuine signature is badly aligned with the reference set, there will be an increase in FRR.

Segmentation of off-line signature using some sense of *Dynamic Time Warping* (DTW) in determining peaks and valleys by I.Guler et al. (2008) is a good approach in off-line signature verification. However, segmenting a heavily criss-

crossed signature is the biggest challenge as it is hard to justify which stroke is earlier then which stroke. For that, mapping the segments in those signatures is merely impossible.

So, the research question of this study is: Could the skeleton matching of strokes in signatures that earlier segmented using DTW improve the FRR and FAR in on-line signature verification?

1.4 Objectives

The objectives of this project can be summarized as follows:

i) To developed different mapping technique in signature verification.
ii) To design the stroke-to-stroke matching technique for on-line signature verification.
iii) To compare the effectiveness of mapping technique.
iv) To compare the effectiveness of stroke-to-stroke matching technique

1.5 Project Scope

The scope of the study is given as follows:

i) The study will use the official dataset from Signature Verification Competition 2004, SVC2004

ii) Testing of algorithm will be done using Matlab.

iii) The comparison of the results is between the stroke-to-stroke technique and the segment-to-segment technique.

1.6 Significance of Project

Signature just like thumbprint is a very old type of personal identifier but yet it is still socially acceptable. In Malaysia for example, usage of thumbprint that applied electronically and kept as digital image is a norm. To list a couple, clocking in the attendance system and opening door using smart card without thumbprint verification are already outdated. MyKad for example, has digital image of thumbprint kept in the memory chip as a mean of security that could verify the owner of the card and eventually could also be compared with the national database. Historically, this was what happened to thumbprint. Looking at the evolution of thumbprint as a trend of change, it is very much possible that signature, in the near future will be applied on electronic devices rather than conventional paper.

Furthermore, still images like thumbprints that are currently being widely used have its own drawbacks as well. One of the major drawback in still images is, with the current hardware technology is, a synthetic thumbprint could easily be made. Some devices that depends solely on image recording like the devices that are widely used now fails to differentiate between real thumbprint and a good copy of the thumbprint. So, a device that could record, compare and verify sets of movements like the on-line signature would solve the issue arose in the still image verification.

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