

Intra-class Variation Representation for On-line Signature Verification Using Wavelet and Fractal Analysis

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Abstract— Signature is an important legal personal identification. Selecting a good feature representation is a significant step in designing a signature verification system. Single resolution function approach used in on-line signature verification faces the difficulty in identifying the intra-class variations of the features extracted. Such an approach might cause the acceptance of forged signatures that have similar patterns as the original and the rejection of genuine signatures that have high intra-class variations. This paper discusses the intra-class variation representation in on-line signature verification using wavelet and fractal analysis. With the achievement performance of an average improvement of 18% in genuine test verification rate and 7% in forged test verification rate compared to the single resolution function approach, it proves that the intra-class variations are important for on-line signature verification.

Keywords—on-line signature; intra-class variations; wavelet; fractal dimension

I. INTRODUCTION

Signature as one accepted means of personal identification is formally used for various applications in many countries especially for issuing official documentation such as in banks, property deals and forensic documents services [1, 2]. However, signature verification is usually done using a simple way by comparing the appearance of two signature using human eyes without real systematic verification [3]. The accuracy of the judgment done by visual inspection is subjective and questionable since different people can give a different view. Therefore, it is important to have a reliable signature verification system in order to ensure that the signature is genuine before any authorization takes place.

Signature verification is a set of procedures which can distinguish a genuine signature from a forged signature [14]. There are two types of handwritten signature verification: off-line handwritten signature verification and on-line handwritten signature verification [4]. Off-line handwritten signature verification studies the result of the action of signing from a signature image while on-line handwritten signature verification studies the action of signing itself through features like a sequence of signature coordinates, pressure, speed and

time [5, 6]. The advanced development in mobile technology has result in the interest in researching on-line signature verification as an alternative of biometric modality [4].

Signature stability is one of the issues in the signature verification task. A lot of variations can be observed in signatures according to the country, age, time, habits, psychological, physical and practical conditions [13]. This has led to the difficulties to determine the two types of signature variations that have been clearly distinguished: intra-class and inter-class variations [13]. Intra-class variations refer to the differences within signatures produced by the same signer while inter-class variations are the differences between signatures, which are produced by two different signers. A signature verification system not only should be able to detect forged signatures, it also should be able to avoid the rejection of genuine signatures [6]. Therefore, the features selected for verification should not only have minimum intra-class variations but also high inter-class variations. Minimum intra-class variations show the stability in the signatures from the same signer while high inter-class variations help to differentiate the signatures from different signers.

The outline of this paper is as follows. The following section describes the intra-class variations representation for online signature verification. This section also discusses the proposed multi-resolution approach of using wavelet analysis and fractal dimension. Section III presents the construction of individual cumulative threshold used in this study. The database used is discussed in Section IV while the results and discussion are presented in Section V. The paper ends with conclusions and future works in Section VI.

II. INTRA-CLASS VARIATION REPRESENTATION

Generally, signature verification schemes are based either on a parameter or on a function approach. Parameter approach is a method that characterizes the signature as a vector of elements each representing a value of a feature such as height or width ratio of the stroke and total signing time [15]. Function approach is a method in time sequences describing local properties of the signature used for verification [7]. Such approach normally is applied to online-signature verification.