On-line Signature Verification on a Mobile Platform

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Abstract. This paper concerns the implementation of our online signature verification system on a mobile device. Verification involves confirming or denying a person's claimed identity. Our system is based on a Hidden Markov Model and outputs two complementary scores: the first one is related to the likelihood given by the HMM of the claimed identity; the second one is related to the segmentation given by such an HMM on the input signature. A claimed identity is confirmed when the arithmetic mean of the two scores obtained on such an input signature is higher than a threshold. Also, a personal normalization of the local parameters of the signature is carried out to make the system robust to changes of platforms. A patent was submitted with special emphasis on the latter claim. This system is implemented on a mobile platform PDA Qtek 2020 ARM 400 MHz. An acquisition interface is developed allowing an enrollment step of a person by acquisition of 5 of his/her signatures, and a verification step of a given signature of a registered person. Enrolment speed depends on the complexity of the signature, while verification is performed in real time. Performance assessment of our system, carried out on two databases acquired on a PDA, shows a degradation of system performance on mobile platform compared to a fixed platform. In order to improve the performance in the case of mobility, we propose a strategy for enhancing the quality of the reference signatures at the enrolment phase.

Keywords: Online signature verification, PDA device, Mobile conditions, Hidden Markov Models.

1 Introduction

Online signature differs from offline (static one, which is affixed to the bottom of a letter or a check) in that it is acquired on a special terminal (digitizing tablet or PDA) or using a special pen (Anoto) that records the sequence of points plotted during the dynamic signing process. In this way, we get directly a temporal signal (see Figure 1), namely the sequential coordinates of plotted points, unlike the static signature that corresponds to an image after digitization. Several studies (including ours) have shown that using online signature allows obtaining better recognition performance than using off-line signature, particularly because online signature can encode the

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dynamics of the signature, which is less variable for a given person than the shape alone, and also because the gesture of signing is more difficult to falsify than the signature image.

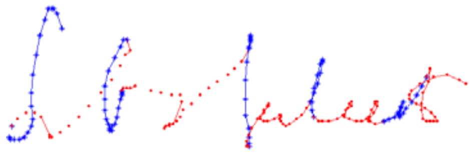

Fig. 1. Example of an online signature and the corresponding point's sequence

Signature is an interesting biometric modality for automatic person authentication due to the fact that it is highly accepted by the population, the latter having been using it for ages on paper documents. Moreover online signature can be recorded without the need of any extra sensor on all mobile devices that possess a tactile screen. Such devices are nowadays largely deployed all over the population for various usages. In general, their protection against theft is rather limited as person authentication is ensured thanks to a code pin, which can even be optional. This is not sufficient for applications such as mobile banking, financial transactions, access to a medical database, contract signing through internet, etc. In these situations, a stronger user authentication on the mobile device is needed before allowing the transaction. Biometric modalities can be used to this end and some smart phones already use fingerprints (with a special acquisition device) [1].

The object of the MOBIO project is the study of the feasibility of face and voice in this mobility context [2]. Online signature is another possibility, which has been envisaged by Martinez-Diaz et al. [3] who nevertheless stress the loss of performance encountered in the mobility context as compared to acquisition on a fixed digitizing tablet.

The aim of this paper is to describe our signature verification system (called TSP) as well as its implementation on a mobile device. We will also present different comparative performance evaluations on a digitizing tablet (fixed platform) and on a PDA (mobile platform). Finally, we propose some possible ways to improve the performance in the case of mobility.

2 The TSP Signature Verification System

Our system, described in details in [4], is based on several important characteristics:

- An extraction of 25 relevant parameters at each point of the signature representing the dynamic information (ex: speed, acceleration) and the local spatial context.
- Modeling the signatures of a person by a Hidden Markov Model that allows taking into account the intra-class variability between the different signatures of the same person.

- The fusion of two complementary scores from this model, corresponding to two levels of signature description: the likelihood score computed locally on each point of the trajectory and the segmentation score computed on portions of the signature.
- Personal normalization of the parameters of the signature in order to make the system robust to different acquisition sensors (digitizing tablet, pen, PDA). A patent [5] was submitted with special emphasis on the latter claim.

This system has been tested on many databases of a hundred people, gained over a digitizing tablet. Note that in each database, imitations of the signature of each person of more or less good quality are available (skilled forgeries). This makes it difficult for the system to both recognize the signatures from the same individual and discriminate the authentic ones from imitations. Tests are also performed with random forgeries (genuine signatures of other persons in the database).

In [4], an average Equal Error Rate (EER, corresponding to as many false rejections as false acceptances) around 3.5% is obtained when the system is tested with skilled forgeries. With these figures, our system is one of the best from the state of the art, and is proposed as a reference system by the BioSecure Association [6].

3 Implementation on a PDA

This system has been implemented on a mobile platform PDA Qtek 2020 ARM 400 MHz in 2006 in the framework of the SecurePhone European project. An acquisition interface has been developed, which allows two types of processing: an enrollment step of an unknown person by acquisition of 5 of his/her signatures, which are stored in the PDA as references of the person; and a verification step of a given signature of a registered person.

4 Performance Evaluation

The system has been evaluated on two different databases acquired on a PDA, namely PDA-64 containing data of 64 people, and BioSecure DS3-210 [6] containing data of 210 people.

The experiments show a degradation of performance when using a mobile digital device instead of a fixed digitizing tablet. Indeed, as mentioned above, an average EER of 3.5% is obtained on fixed platforms with skilled forgeries, while on PDA-64, the EER is of 16.02% (Figure 2), and of 9.95% on DS3-210 (in case of no time variability on Figure 3). This is due to the fact that signatures of a given person are altered on mobile platforms as the writer signs while standing and holding the PDA on his/her hand. This makes signatures in general less complex and more variable, leading to a decrease of performance, which is particularly visible when the reference and test signatures are time-spaced (see Figure 3, in the case of time variability with an EER of 12.32% for skilled forgeries).

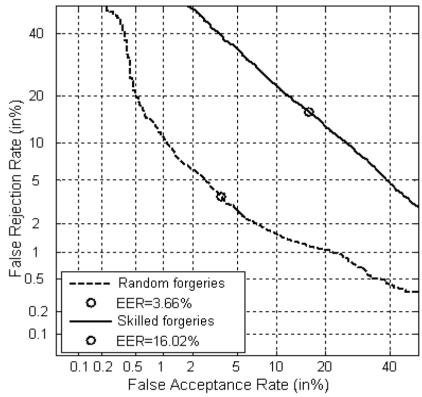

Fig. 2. System performance on a home-made "PDA-64" database for random and skilled forgeries

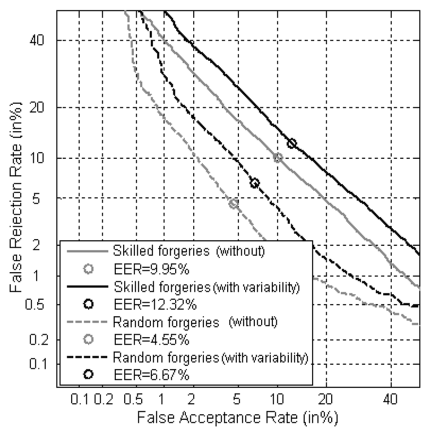

Fig. 3. System performance on "BioSecure DS3-210" [6] database acquired on 2 sessions. Performance is shown for random and skilled forgeries, with and without time variability (intra and inter sessions).

5 Conclusion

In order to improve the performance in mobile conditions, we propose a strategy for enhancing the quality of the signature references. Indeed we have shown in [7] that an entropy quality measure can be used for selecting good quality reference signatures at the enrollment phase. Moreover, our results in [7, 8] show that using "good" quality signatures improves significantly the verification results. We also suggest proceeding at regular time steps when re-enrolling the persons in order to face the time variability of online signatures.

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