Available online at www.sciencedirect.com
SCIENCE DIRECT®

Pattern Recognition Letters 26 (2005) 2390–2399

Pattern Recognition Letters

www.elsevier.com/locate/patrec

Off-line Chinese signature verification based on support vector machines

Hairong Lv *, Wenyuan Wang, Chong Wang, Qing Zhuo

Department of Automation, Tsinghua University, Beijing 100084, China

Received 12 April 2004; received in revised form 12 April 2005
Available online 22 June 2005

Communicated by T. Breuel

Abstract

This paper proposes a novel off-line Chinese signature verification method based on support vector machines. The method uses both static features and dynamic features. The static features include moment features and 16-direction distribution (an improvement on 4-direction distribution). The dynamic features include gray distribution and stroke width distribution. At last, support vector machine is used to classify the signatures. The main steps of constructing a signature verification system are discussed and experiments on real data sets show that the average error rate can reach 5%, which is obviously satisfactory.

Keywords: Signature verification; Moment features; Direction distribution; Gray distribution; Stroke width distribution; Support vector machines (SVM)

1. Introduction

Handwritten signature is one of the most widely accepted personal attributes for identity verification. As a symbol of consent and authorization, especially in the prevalence of credit cards and bank cheques, handwritten signature has long been the target of fraudulence. Therefore, with the growing demand for processing of individual identification faster and more accurately, the design of an automatic signature verification system faces a real challenge.

Handwritten signature verification can be divided into on-line (or dynamic) and off-line (or static) verification. On-line verification refers to a process that the signer uses a special pen called a stylus to create his or her signature, producing the pen locations, speeds and pressures, while

* Corresponding author. Tel.: +86 1062773349.
E-mail address: lvhairong@tsinghua.org.cn (H. Lv).

0167-8655/$ - see front matter
doi:10.1016/j.patrec.2005.04.013

off-line verification just deals with signature images acquired by a scanner or a digital camera.

In general, off-line signature verification is a challenging problem. Unlike the on-line signature, where dynamic aspects of the signing action are captured directly as the handwriting trajectory, the dynamic information contained in off-line signature is highly degraded. Handwriting features, such as the handwriting order, writing-speed variation, and skillfulness, need to be recovered from the grey-level pixels.

During the last few years, researchers have made great efforts on off-line signature verification. Ng and He used a neural network expert system to identify Chinese signature (Ng and Ong, 1993; He et al., 2002). Yingyong and Hunt used some global and grid features to compute the Euclid distance of two signatures (Yingyong and Hunt, 1994). Buryne tried to apply elastic image matching in signature verification (Buryne and Forre, 1986). Methods based on texture analyses were also applied in the area, with works by Liu et al. (1997) and Liu (1997). Peter Shaohua discussed the possibility of applying wavelet on signature verification in their paper of 1999 (Peter Shaohua et al., 1999). Justino and El-Yacoubi developed a signature verification system based on Hidden Markov Model (HMM) (Justino et al., 2001 and El-Yacoubi et al., 2000). Wan and Lin presented a off-line signature verification system that only requires the genuine signatures of a new user (Wan et al., 2003).

There are three classes of forgeries: random forgeries, simple forgeries and skilled forgeries. Most systems mentioned above are designed for simple forgeries and random forgeries.

In this paper, a novel approach for off-line signature verification system is proposed based on support vector machines. It combines four feature sets: moment features, 16-direction distribution, gray distribution and stroke width distribution. Support vector machine is employed to identify the signature images. The system is effective for not only simple forgeries and random forgeries, but also skilled forgeries.

The remainder of the paper is organized as follows: Section 2 introduces the database used in the experiments; Section 3 discusses the preprocessing stage; Section 4 describes the features we select and how to get them; Section 5 provides a brief introduction to support vector machines; In Section 6 the verification strategies and experimental results are presented; Section 7 presents the conclusion and future work.

2. Database

The signature database consists of 1100 signature images, scanned at a resolution of 300 dpi, 8-bit grey-scale. They are organized into 20 sets, and each set corresponds to one signature enrollment. There are 25 genuine and 30 forgery signatures in a set. Each volunteer was asked to sign his or her own signatures on a white paper with

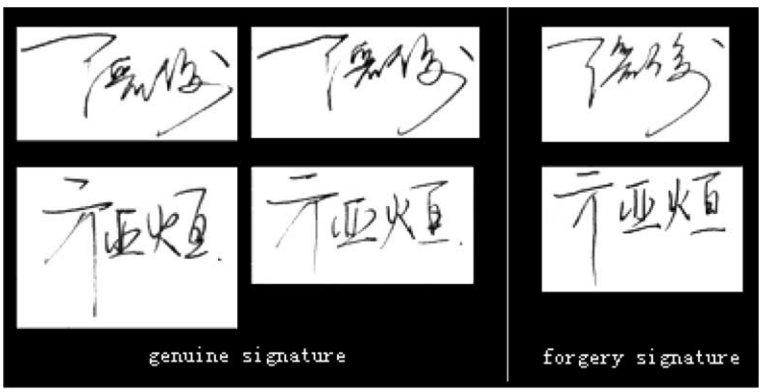

Fig. 1. Genuine and forgery signatures.