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Abstract. *We present a nonconstraining and low-cost online signature acquisition system that has been developed to enhance the performances of an existing multimodal biometric authentication system (based initially on both voice and image modalities). A laboratory prototype has been developed and validated for an online signature acquisition.* *[DOI: 10.1117/1.JEI.22.1.010501]*

1 Introduction

Signature-based authentication systems are an attractive method for biometric authentication because they are cheaper and less constraining than fingerprint or iris-based methods. In addition, signatures are a socially and legally acceptable means for personal authentication.[1] We propose a low-cost, camera-based method for capturing signatures that can be used as an accurate biometric authentication method.

Biometric authentication systems require sensors adapted to the special requirements of the task, with the number and type of sensors depending on the required accuracy and sensitivity of the final authentication. While monomodal systems are easier to implement, they generally provide limited accuracy and sensitivity. Alternatively, multimodal systems are generally more accurate and expensive.[2,3]

Unlike offline signature authentication methods,[4] online methods involve the following operations:

- Dynamic signature acquisition.
- Data pretreatment (adapted to the process and the conditions of acquisition).
- Static and/or dynamic features extraction.
- Similarity measure with reference signatures.
- Authentication decision (true or false identity).

Several systems have been developed to perform an online signature acquisition. Most of them are based on video camera systems,[5] or digital tablets (tablet personal computers, personal digital assistants, etc.)[6] Although they guarantee satisfactory results, the systems that use one or two cameras for the dynamic capture of the signature are sensitive to variations of lighting (shade produced by the movements of the hand), and cannot be easily adapted to real-world systems (such as control access systems). Moreover, systems using digital tablets seem more practical than those based on cameras; however, they are relatively more expensive and require more dedicated material for the exploitation of acquired data. Other types of acquisition systems based on a data glove (conceived initially for virtual reality) have also been developed for the same purpose.[7] The latter are powerful, but very constraining and not suitable for a general public use.

In Ref. 6, "It would also be possible to have a system in which the user signs with an ink-less pen, leaving no trace of the signature in order to prevent possible forgers from knowing it."

This article will show it is possible to have a system in which the user signs with his hand, leaving no trace of the signature in order to prevent possible forgery. Indeed, by regarding the signature as a specific dynamic hand activity and not as the result of this activity on paper or digital support, we have been able to propose a new online signature acquisition device allowing the construction of low-cost and nonconstraining signature authentication systems. The following describes the basic principle of our method and its validation using our own developed prototype.

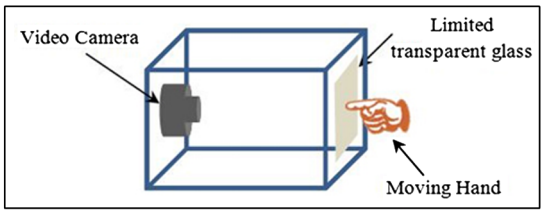
2 Proposed Method

By replacing the pen by the hand finger (the index finger in our case) and paper by a transparent glass placed in front of the camera (see Fig. 1), it is possible to carry out specific movements which can characterize a signature. Consequently, these movements can be captured dynamically using a video camera where the index finger is covered with a marked cone to ensure a precise motion tracking, and to avoid finger tracing constraints.

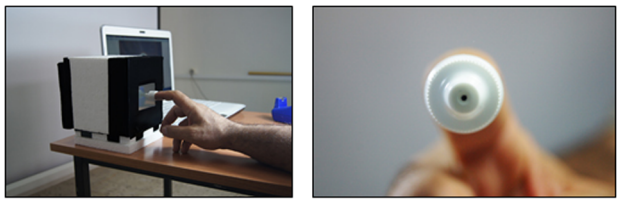
The proposed acquisition prototype is composed of:

- rectangular box;
- video camera placed on a side of the box;
- thick transparent glass placed on the other side of the box.

Such a device is well-suited for integration within systems dedicated to control isolated access, because not only it can



(a) Signature acquisition system



(b) Laboratory Prototype (c) Selected frame with moving index

Fig. 1 Developed system.

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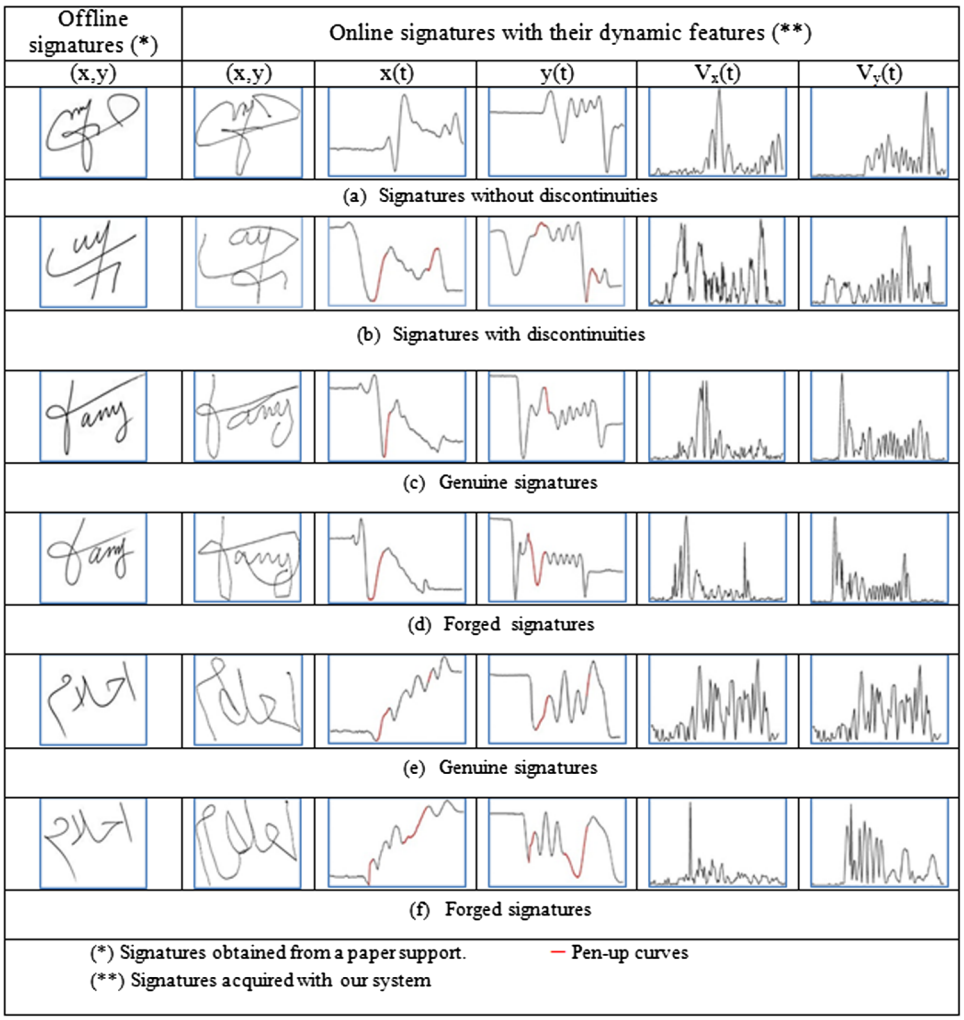

Fig. 2 Signature analysis experiments.

be easily hidden in a wall but it also does not require visible signature and makes any attempt of fraudulent imitation very difficult.

3 Results and Discussion

Any person who wishes to be identified would place his/her index finger on glass and create a signature that will be recorded by a video camera. The acquired sequence is then decomposed on frames in order to extract the required features for a signature reconstruction and authentication.[8] A comparison between offline signatures (obtained from a paper support) and online signatures (obtained with our system) is presented in Fig. 2. In case of continuous signatures, the similarity is identical [Fig. 2(a)]; however, any discontinuity in a signature on nontransparent support (pen-up) will be presented as a continuous curve with our system [Fig. 2(b)]. As these pen-up movements constitute a nonvisible signatory behavior, they are difficult to forge. The examples in Fig. 2(c)–2(f) show that it is easier to perform a good forgery in an offline system than an online system. Indeed, taking into account the pen-up movements will ensure a precise signature analysis and will make the forger's task very difficult.

It is important to note the nonvisibility of the signature is directly related to the transparency of the glass. If this condition is not guaranteed, the signature is likely to become visible, which might allow a malicious person to determine and then forge the signature.

For enhanced security, it would be possible to equip the system with a smart glass protector and to develop dedicated software capable of periodically checking the glass cleanliness. If the desired state is not satisfied, then the acquisition process is locked until the glass has been wiped in case of ordinary finger traces, or replaced in case of damaging traces.

4 Conclusion

In this work, an original, low-cost, online signature acquisition system has been presented to suit security embedded applications (such as real-time control access within isolated places). Developed system includes the pen-up movements in the signature analysis process, which makes it more precise than classical systems. Moreover, the system can be easily hidden in a wall and equipped with a smart glass protector capable of periodically checking the glass for cleanliness, and to prevent any fraudulent signature imitations attempts. These required improvements are the subject of our current work.

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References

1. S. Sayeed et al., "Online hand signature verification: a review," *J. Appl. Sci.* **10**(15), 1632–1643 (2010).
2. A. Mishra, " Multimodal biometrics it is: need for future systems," *Int. J. Comput. Appl.* **3**(4), 28–33 (2010).
3. M. I. Razzak et al., "Multimodal biometric recognition based on fusion of low resolution face and finger veins," *Int. J. Innov. Comput. Info. Control* **7**(8), 4479–4689 (2011).
4. A. K. Jain, F. D. Griess, and S. D. Connell, "Online signature verification," *Pattern Recogn.* **12**(35), 2963–2972 (2002).
5. I. Nakanishi et al., "DWT Domain On-Line Signature Verification," Chapter 9 in *Biometrics*, J. Yang, Ed., pp. 183–196 (2011).
6. M. E. Munich and P. Perona, "Visual identification by signature tracking," *IEEE Trans. Pattern Anal. Mach. Intell.* **25**(2), 200–217 (2003).
7. S. Sayeed, N. S. Kamel, and R. Besar, "Virtual reality based dynamic signature verification using data glove," in *Int. Conf. Intell. Adv. Sys.*, pp. 1260–1264 (2007)
8. G. K. Gupta, "The state of the art in the on-line handwritten signature verification," Clayton School of Information Technology, Monash University, Melbourne, Technical Report 200 (2006).