Finger Vein Recognition Systems for the Biometric Authentication of Individuals

Christos Vasilopoulos and Athanassios Skodras
Electrical and Computer Engineering Department, University of Patras

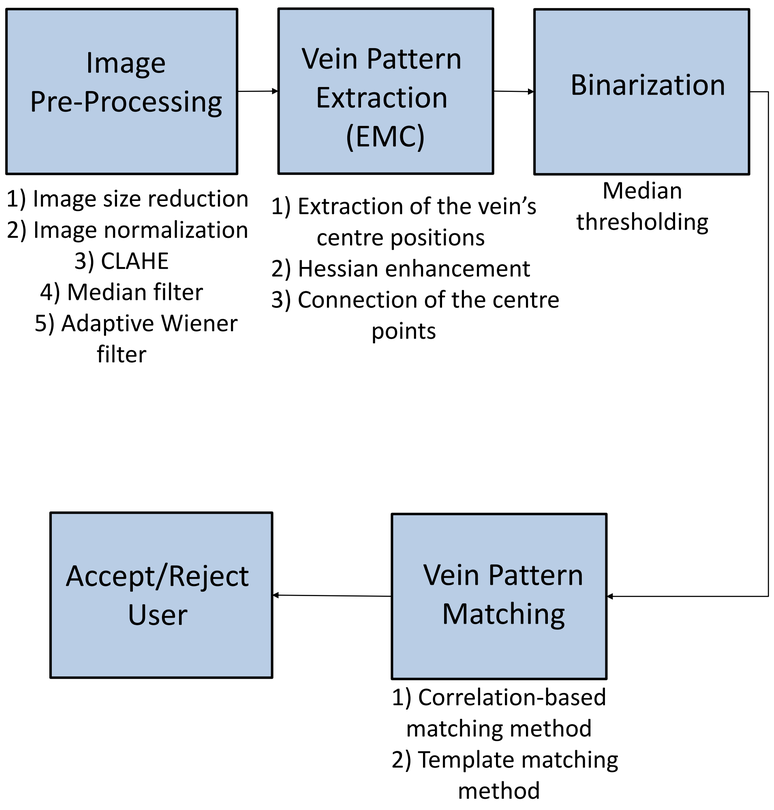
Abstract

Finger vein recognition is a biometric method of authentication that offers high security, efficiency and stability. We propose two new finger vein recognition systems (utilizing one finger and three fingers) that utilize the Enhanced Maximum Curvature Points (EMC) method for finger vein pattern extraction. We present the experimental results obtained by applying our system on the databases SDUMLA-HMT, Tsingua, FV-USM and HKPU and compare them with other methods applied on these databases. Our systems offers better performance in terms of EER, FAR, FRR and recognition rate than other methods.

Introduction

Personal identification is a matter of great importance and is used in a wide range of systems where restricted access is essential, such as ATM systems in banks, access to PCs, companies, hospitals and military buildings. However conventional methods, such as passwords and PIN numbers, can be stolen, forged or lost. Biometric identification has appeared in order to offer systems of high security, efficiency and stability and also to overcome the disadvantages the conventional methods have. Biometric identification includes systems that utilize voice, iris, face recognition, fingerprints, etc [1]. Finger vein recognition is a new biometric method for identification of individuals that has emerged in order to offer higher security, ease of use, accuracy and low cost compared to other biometric methods of identification [2].

Finger vein recognition technology is based on finger images captured using near infrared light (700 – 1000 nm) because only this wavelength is absorbed by the hemoglobin in the blood of the veins and thus makes the vein pattern visible. This fact offers high security because finger vein pattern is internal in the human body and can become visible only by this method, a fact that makes very difficult to impossible for vein pattern to be forged or stolen [3].



Method

I. Finger Vein Image Pre-Processing

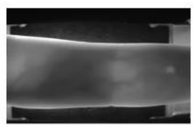


Figure 2. Resized Finger vein image

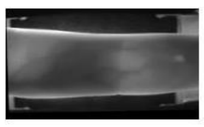


Figure 4. Finger vein image after image normalization

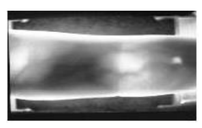


Figure 6. Finger vein image after CLAHE

Figure 3. Finger Vein region

Figure 5. Finger vein region after image normalization

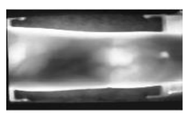


Figure 7. Finger vein image after Median filter

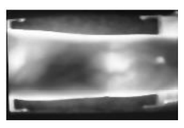


Figure 8. Finger vein image after adaptive Wiener filter

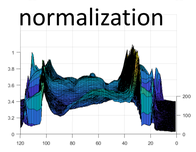


Figure 9. Finger vein image surface plot before pre-processing

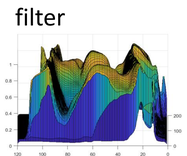


Figure 10. Finger vein image surface plot after pre-processing

II. Vein Pattern Extraction with EMC method

➢ Extraction of the vein's centre positions

In this step the centreline of the veins is extracted by checking the cross-sectional profile of the image. The local maximum curvature points are calculated and so the centre position of the veins is determined [4].

➢ Hessian enhancement

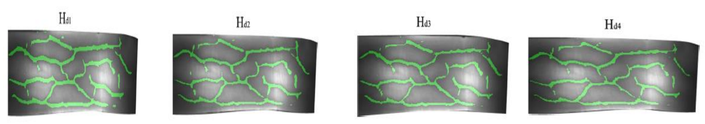


Figure 11. Vein structure in four directions (horizontal, vertical and the two diagonals)

➢ Connection of the centre points

At this step the connection of the vein centres is performed and noise is eliminated from vein line structures H_{d1}, H_{d2}, H_{d3} and H_{d4} [4].

III. Binarization

The threshold t for the binarization is the mean intensity value of the two median intensity values of pixels having value other than 0 in the image, sorted in ascending order.

Figure 11. Finger vein pattern after binarization

IV. Vein Pattern Matching

➢ Correlation-based matching method

This distance measure is correlation-based, meaning that two binary images containing vein patterns are compared through their correlation [5].

➢ Template matching method

This distance measure considers possible displacements in vertical and horizontal direction of the examined vein patterns [6].

Results

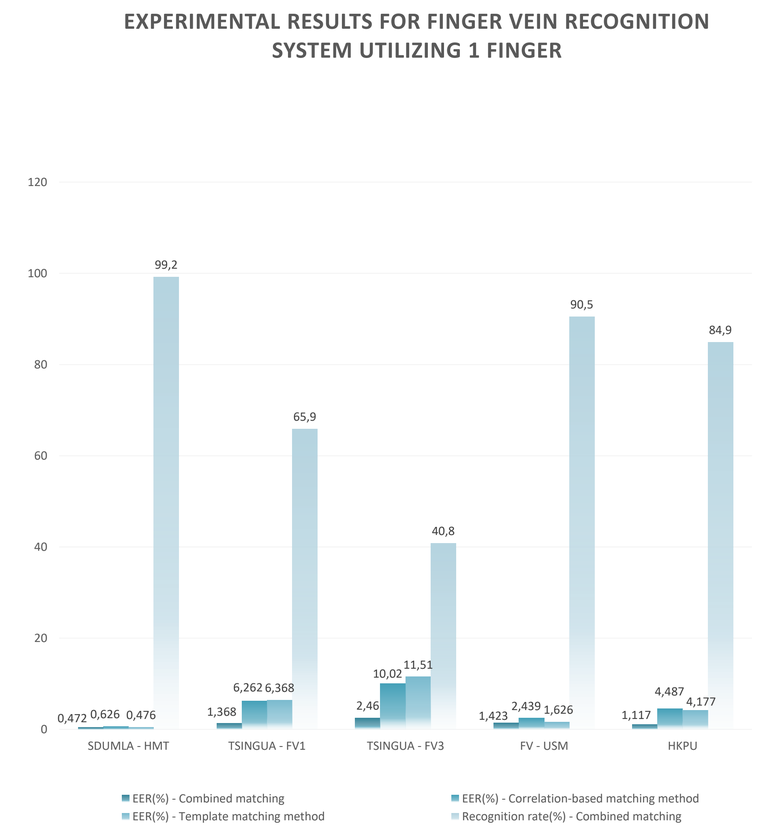


Figure 12. Experimental EER results for finger vein recognition system utilizing 1 finger with each of the two matching methods, with their combination and recognition rate achieved with the combination of the two matching methods on SDUMLA – HMT [7], TSINGUA, FV-USM [8] and HKPU [9] databases.

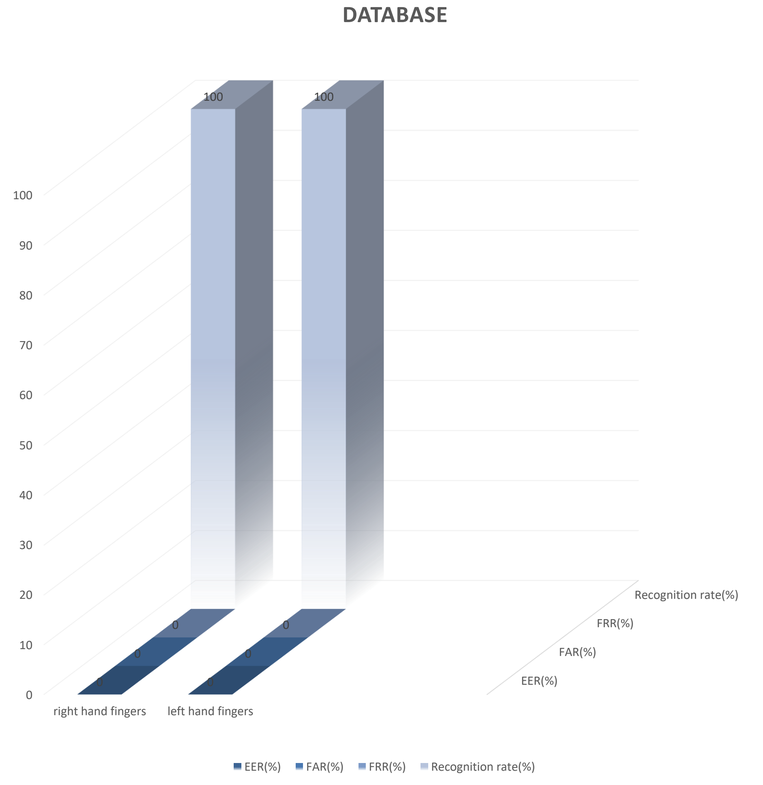


Figure 13. Experimental EER, FRR, FAR and recognition rate results for finger vein recognition system utilizing 3 fingers with combination of the two matching methods on SDUMLA – HMT database.

Conclusions

We have proposed new finger vein recognition systems that achieve better EER, FAR, FRR values and recognition rates than other methods in literature. Also, they offers better recognition rates and less time needed to recognize a user against other methods. Combining this method with the use of PIN, a further reduction of the complexity and thus the time needed for recognition, is achieved. These systems can offer viable solutions for the efficient finger vein recognition.

Contact

Christos Vasilopoulos
Electrical and Computer Engineering Department, University of Patras
vasilopoulos@upatras.gr

Athanassios Skodras
Electrical and Computer Engineering Department, University of Patras
skodras@ece.upatras.gr

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