Review of Biometrics: Palm Vein Recognition System

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ABSTRACT

Biometrics refers to the identification of humans by their characteristics or traits. It is the science and technology of measuring and analyzing biological data. Biometric identifiers are often categorized as physiological or behavioral characteristics; among the features measured akin to face, fingerprints, hand geometry, handwriting, palm vein, iris, retinal, and voice etc. This paper discusses about palm vein biometric systems. The system is superior because it provides a nontransferable means of identifying people. The vein patterns are not easily spoofed, observed, damaged, obscured or changed. It is perceived as secure and integrated with "aliveness" detection. Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. The biometric data is based on human vein characteristics that stay constant throughout one's lifetime. A paper discusses about a palm vein technology, which gains much of the advantages over the traditional biometrics. The research states that human vascular structure is individually distinct. Even identical twins have different and distinct vascular patterns. The paper discusses about vein pattern recognition, imaging principles and image databases.

Keywords: Authentication, Blood Vessel, Multimodal Biometrics, Multispectral Image, Pattern Recognition, POLYU.

Introduction

Biometrics is automated methods of recognizing a person based on a physiological or behavioral characteristic; among the features measured akin to face, fingerprints, hand geometry, handwriting, iris, retinal, palm vein, and voice etc. Hong, Jain, and Pankanti (2000) states biometric identifiers are the distinctive, measurable characteristic; which are used to label and describe individuals. However Palm vein biometric systems are superior because they provide a nontransferable means of identifying people not just cards or badges. A key advantage of palm vein biometric authentication is that biometric data is based on human vein characteristics that stay constant throughout one's lifetime and are difficult (some more than others) to fake or change. A study of Alisherov, Kim, Sarkar, and Bhattacharyya (2010) shows however, the palm vein patterns are internal to the body; it makes a difficult method to forge. A palm vein is a new member of biometrics family and attracts much of the today's research attention. Zhang, Guo, Lu, Zhang, and Zuo (2010) experiment shown that light in the 700 to 1000 nm (infrared light) ranges can penetrate human skin, whereas 880–930 nm provides a good contrast of subcutaneous veins. When such light illumination passed through hand with de-oxygenated hemoglobin appears as a black pattern showing as a lighter color or white. As palms have more complex vascular patterns than fingers and provide more distinct features for pattern matching and authentication. Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm.

Palm Vein Pattern

Vein pattern identification uses an infrared light source to scan for hemoglobin in the blood. De-oxygenated hemoglobin appears as a black pattern with the hand or finger. The device then captures an image of vein patterns in wrist, palm, back of the hand, finger or face. This is similar to the technique used to capture retinal patterns. As per the observation of Miura (2007)), the backs of hands and palms have more complex vascular patterns than fingers and provide more distinct features for pattern matching and authentication. As with other biometric identification approaches, vein patterns are considered to be time invariant and sufficiently distinct to clearly identify an individual. As it is found, the physiological biometric can be easily forged by undergoing medical operation and resulted into the medical identity loss of the person. So a strong and robust biometric feature such as palm vein can be studied and adopted for person

identification. Aliveness can be detected by monitoring the blood fluctuation in the vein as heart pump.

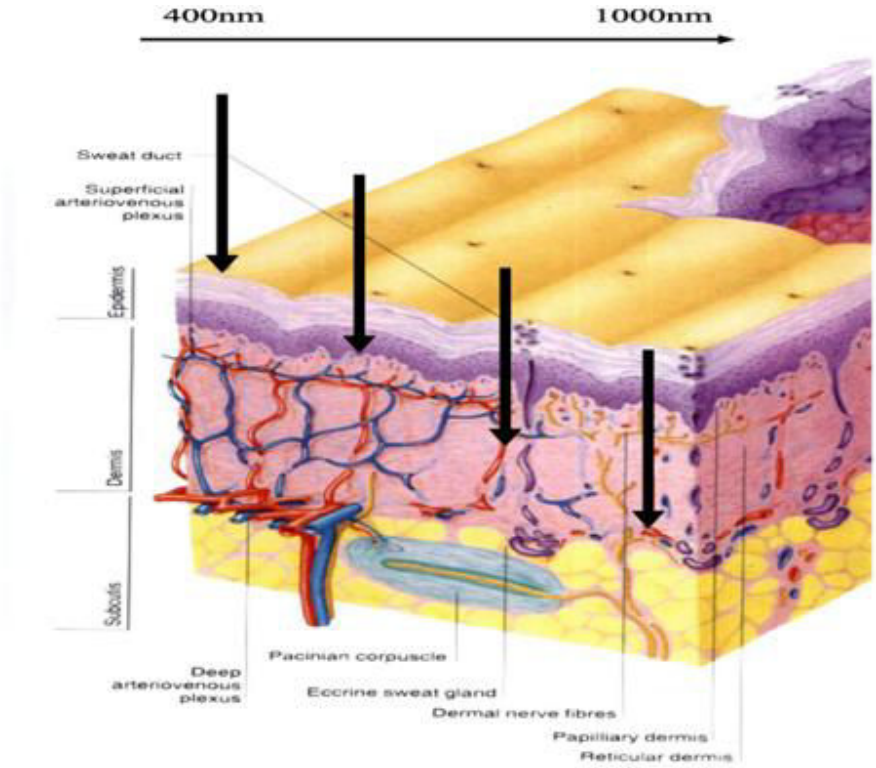

Figure 1: Cross-sectional view of the skin.

The two basic considerations in the design of a multispectral palm print system are the following:1) the color-absorptive and color-reflective characteristics of human skin and 2) the light spectra to be used when acquiring images. Human skin is made up of three layers: 1) epidermis; 2) dermis; and 3) sub cutis, as shown in Fig. 1. Each layer will contain a different proportion of blood and fat. Gawkrodger (2002) states the epidermis also contains melanin, whereas the sub cutis contains veins. Different light wavelengths will penetrate to different skin layers and illuminate in different spectra. Zharov, Ferguson, Eidt, Howard, Fink, and Waner (2004) states that NIR light penetrates human tissue further than visible light, and blood absorbs more NIR energy than the surrounding tissue (e.g., fat or melanin. Vein patterns are considered to be time invariant and sufficiently distinct to clearly identify an individual. It is perceived as secure and integrated with "aliveness" detection. The vein patterns are not easily spoofed, observed, damaged, obscured or changed.

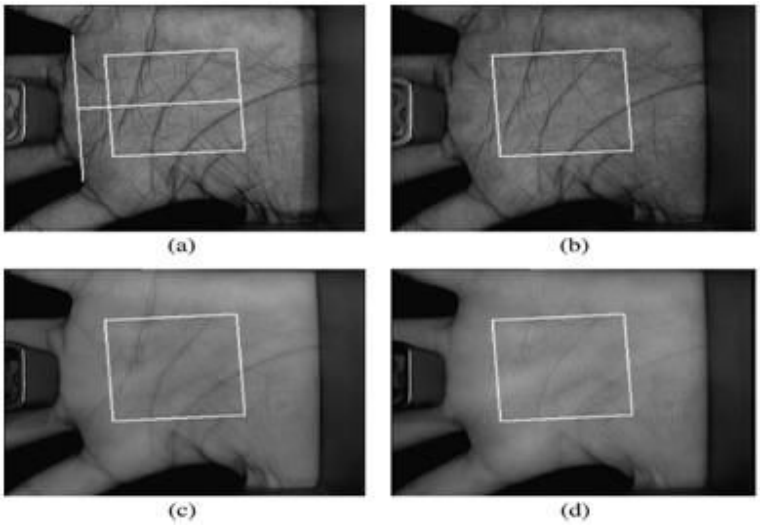

Figure 2: Typical multispectral palm print sample (a) Blue,(b) Green. (c) Red. (d) NIR. The white square is the ROI of the image

The system acquires spectral information from all three dermal layers by using both visible and NIR bands. In the visible spectrum, a three-monocular LED array is used with Red peaking at 660 nm, Green peaking at 525 nm, and blue peaking at 470 nm. In the NIR spectrum, an NIR LED array peaking at 880 nm is used. As per Zharov et al. (2004), it has been shown that light in the 700- to 1000-nm range can penetrate human skin, whereas 880–930 nm provides a good contrast of subcutaneous veins.

Image Database

The Biometric Research Centre (UGC/CRC) at the Hong Kong Polytechnic University. Zhang et al. (2010) has developed a real time multispectral palm print capture device which can capture palm print images under blue, green, red and near-infrared (NIR) illuminations, and has used it to construct a large-scale multispectral palm print database. Multispectral palm print images were collected from 250 volunteers, including 195 males and 55 females. The age distribution is from 20 to 60 years old. They have collected samples in two separate sessions. In each session, the subject was asked to provide 6 images for each palm. Therefore, 24 images of each illumination from 2 palms were collected from each subject. In total, the database contains 6,000 images from 500 different palms for one illumination. The average time interval between the first and the second sessions was about 9 days. And also provide the extracted ROI images using our ROI extraction algorithm from 500 different palms for one illumination.

Figure 3: An outlook of multispectral palm print image acquisition device

Zhang et al. (2010) forms a database, contains the entire original palm print images collected with their device by blue, green, red and NIR illumination. The average time interval between the first and the second sessions was about 9 days. Each part of database is named as "nnnn". "nnnn" represents the identity of the person (range from 1 to 500). In each folder, the first 6 images (1_mm) were captured in the first session and the latter 6 images (2_mm) were captured in the second session, "mm" represents the image index for give session (range from 1 to 6).

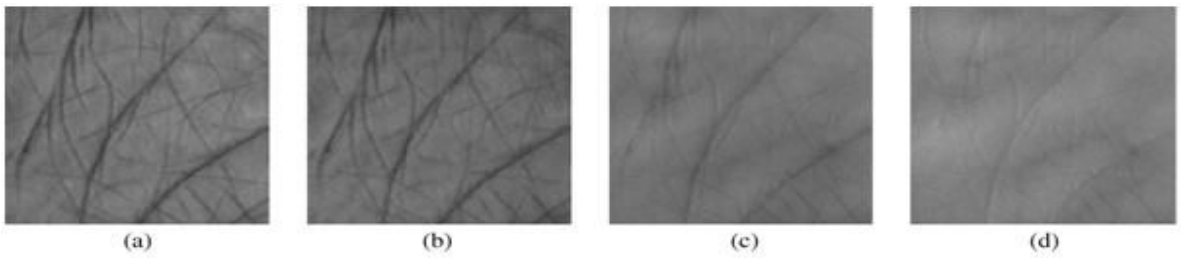

Figure 4: ROI of fig 2 (a) Blue,(b) Green. (c) Red. (d) NIR

Literature Review

Biometrics authentication is a growing field in which civil liberties groups express concern over privacy and identity issues. Today, biometric laws and regulations are in process and biometric industry standards are being tested.

Zhang et al. (2010) developed a palm vein recognition system that uses blood vessel patterns as a personal identification factor. This paper discusses about an image preprocessing and feature extraction of palm vein image. Lingyu and Leedham (2006), investigates two infrared imaging technologies, far-infrared thermographs and near-infrared imaging, to acquire hand vein pattern images for biometric purposes. The imaging principles for both technologies were studied in depth. Deepamalar and Madheswaran (2010), discusses the shape and texture features; which have been considered for recognition of authenticated users and it was validated using neural

network classifier. It is found that the recognition accuracy was 99.61% when the multimodal features fused at matching score level. This proposed multimodal system was expected to provide reliable security. Harmer and Howells (2012), did an investigation into the feasibility of applying the palm-vein biometric modality within a template-free key generation framework were conducted. The experiments resulted in both the key reproducibility and key uniqueness rates achieving 100% with considerable effective key length. Hartung Olsen, Xu, and Busch (2011), shows an approach to extract vein minutiae and to transform them into a fixed-length, translation and scale invariant representation where rotations could be easily compensated. The proposed solution based on spectral minutiae was evaluated against other comparison strategies on three different datasets of wrist and palm vein samples.

Conclusion

The paper discusses about the new era of biometrics that is palm vein recognition system. The palm vein biometrics is much popular nowadays as it is based on human vein characteristics that stay constant throughout one's lifetime and are difficult to forge or change. It is perceived as secure and integrated with "aliveness" detection. Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. Because the palm vein patterns are internal to the body, this is a difficult method to forge. The imaging principle behind image acquisition is an infrared light ranges from 700 to 1000 nm can penetrate human skin. The paper discusses about multispectral image database using which we can gain vein pattern lies at palm region of hand. The reviewed literatures are useful to know about vein recognition system, imaging principle and discover new area of research such as neural network classifiers, spectral minutiae based recognition.

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