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Using Image Processing to Performing Biometric Authentication Applied on Microcomputer Based Hand-Wrist Vein Patterns

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ABSTRACT

A kind of biometric recognition called vein identification systems uses vascular architecture to identify people. One of these approaches is identification based on hand-wrist vein pattern. Hand-wrist vein pictures acquired from persons utilizing an infrared light source with a wavelength of 850 nm were segmented in this research by running them through several image processing techniques. The scale-independent feature transformation (SURF) approach was used to extract critical points from segmented pictures. This strategy has been chosen since it is unaffected by circumstances. During the identification procedure, the retrieved key points were utilized to calculate the Euclidean distance. The accuracy rate was judged to be 97% as a consequence of the matching operations employing The SURF approach produces characteristics such as rotation, camera angle, ambient light intensity, and so on. the database's hand-wrist vein patterns.

Keywords: Hand-wrist identification, Infrared vein imaging, Feature extraction, Surfing.

1.INTRODUCTION

Persons are able to be observed using biometrics based on physiological and behavioral features such as fingerprints, iris, gait, and movement patterns.. While physiological characteristics such as fingerprints, palm prints, and iris are connected to body form, behavioral characteristics such as voice, handwriting signature, and stride are related to an individual's behavioral pattern[1-2].

Among the different biometric aspects, vascular biometry has quickly gained popularity due to benefits such as the uniqueness of the vein pattern from person to person, the difficulty of replicating due to its existence in the skin, and non-contact verification. This characteristic has facilitated the use of the vascular biometric system, particularly in financial applications. Palm authentication processes are widely used in financial applications. In these systems, the palm is put on a platform, and the person's vein pattern is used to identify them. Contact with the surface area may cause the platform to get dusty over time, rendering the vein pattern invisible to the camera. As a result, it is expected that the widespread usage of contactless authentication systems would be more sterile and reduce authentication mistakes owing to contamination related to surface area over time.

The topology of the vascular network is identified by the absorption of near-infrared wavelengths by hemoglobin in the blood and the darker imaging of the vascular areas adjacent to the skin in the infrared camera [3].

Identification based on vein pattern: hand vein pattern [4, 5], finger vein pattern [6, 7], palm vein pattern [8, 9]. The hand-wrist vascular network structure offers a clear image among the four various types of vein patterns because it is placed extremely near to the outer skin and is densely packed.

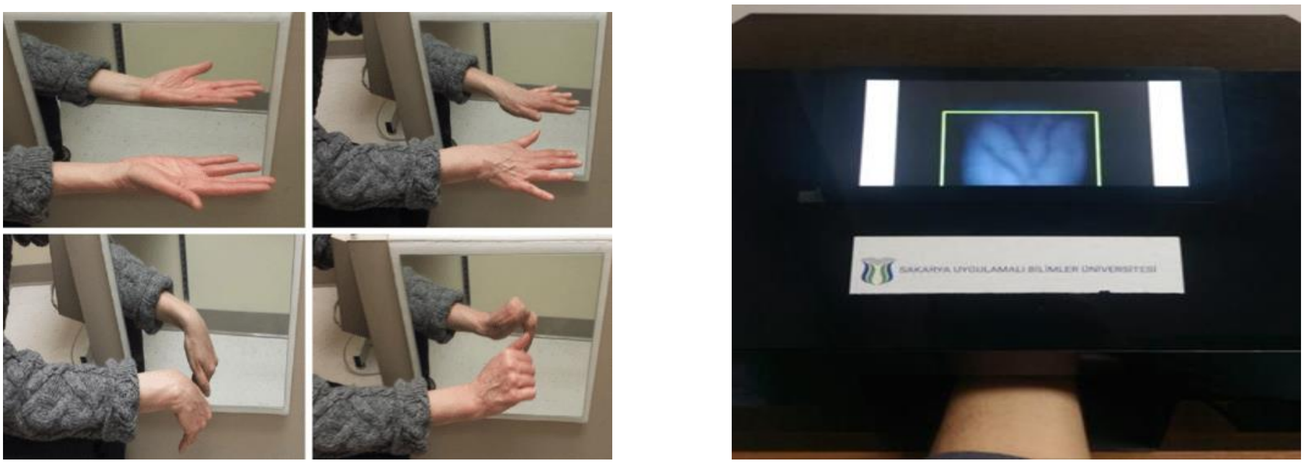
Wrist vein biometry has received little attention in the literature. Akhloufi et al. used a CCD infrared camera to image the vascular network features in the forearm wrist area for their investigation. An anisotropic diffusion technique was used to increase the contrast of the images acquired, and then the vascular network architectures were segmented using morphological procedures [8]. Pascual et al. employed their devised lighting system and infrared camera platform to acquire hand-wrist vein pictures and demonstrated that these images were clear enough to be used in identification [9]. Kurban et al. used a mobile phone camera with a 5 MP resolution to acquire three hand-wrist vein photos from 14 female and 20 male volunteers at different times of the day for their study. Various image processing procedures were done to the pictures in order to boost the visibility of the vascular areas. The photos are first subjected to an FFT-based low-pass filter, which eliminates background noise. The vascular areas were then cleared using the sharpen filter and histogram equalization techniques. Finally, to save processing time, the photos were downsized by one-fifth. The SVM (Support Vector Machine) approach revealed the accuracy rate of the system, which was trained using multiple neural networks, to be 96.07% [10].

The rapid development of artificial intelligence AI and machine learning ML-based computer vision technologies has enabled a wide range of applications. AI and ML in computer vision are used in face identification, ear recognition, medical diagnostics, autonomous driving, mammography, industrial applications, diabetic retinopathy, and many more applications [11].

Image collection, preprocessing of vessel images, feature extraction and representation of vessel images, classifier design, and identification are all common aspects in vessel recognition systems. In practice, the most crucial and hardest element is developing an effective feature extraction approach. The scope of this attempt is to find potential interesting region locations [12].

This paper proposes a low-cost near-infrared-based identification system. First, the vascular network topology was segmented using several image processing methods in the identification investigation using wrist vein pictures. Following that, the SURF approach was used to extract features from the processed pictures. The similarity between the retrieved characteristics was then calculated using the Euclidean distance in the matching stage.

The mechanism indicated in figure 1 was utilized to capture right and left wrist vein pictures from 20 female and 30 male volunteers for a total of 50 subjects included in the study. People were instructed to place their wrists on a hand placement platform lighted by infrared power LEDs with a wavelength of 850 nm, and photographs were acquired from a height of 15 cm using an infrared camera. The procedures had no negative effects on the individuals.



(a) (b)

Figure 1. (a) The system's installation architecture [13] (b) Hand collection phase-images of the wrist

The photos were transported to the microcomputer's digital environment and placed into the image processing and feature extraction algorithms, respectively. The retrieved traits were then saved in the microcomputer environment's database enabling near-real-time authentication.

2. METHOD

Figure 2 depicts the flowchart of the authentication system based on local feature-based hand-wrist pictures. During the system's recording phase, hand-wrist vein images captured with an infrared camera were fed into the SURF algorithm via gray level conversion, contrast limited adaptive histogram thresholding, median filtering, adaptive thresholding, and morphological processes, in that order. The SURF algorithm extracts key points from photos and saves them in the database.

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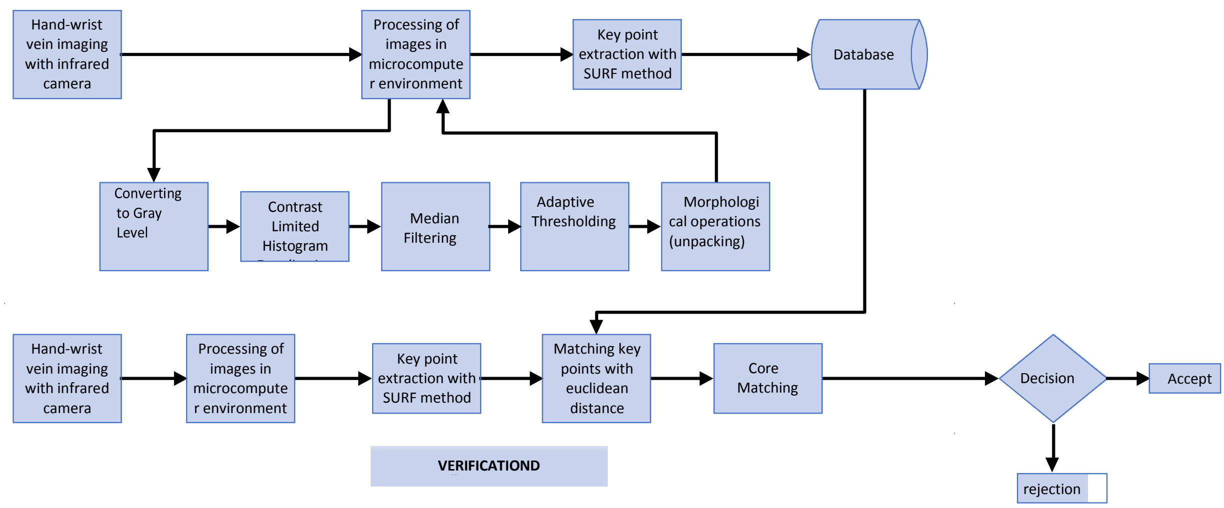

Figure 2. The main foundation of the Hand-Wrist Vein pattern detection system

The camera's real-time hand-wrist vein picture is sent through the image processing processes again in the validation step, and then key point extraction is conducted on the processed image. The key points of previously saved photos in the database are then compared to the important points of the new image. The two photos with the most matching points were acknowledged as the same as a consequence of the processes. The procedures depicted in Figure 2's block diagram are detailed in the sections that follow.

2.1 *Image Processing Algorithms for Vessel Region Segmentation*

Gray level conversion, contrast limited adaptive histogram equalization (KSAHE), median filtering, and adaptive thresholding are performed to the pictures in the initial preprocessing phase. After gray level conversion, KSAHE was performed to the pictures to boost the visibility of the vascular area.

In patients with hairy regions, contrast enhancement in the hand-wrist vein creates noise. The median filter was used to solve this problem. Vessel pictures were transformed to 1-bit using adaptive thresholding after median filtering. Finally, morphological treatments were performed on the 1-bit transformed pictures, which included removing noise and segmenting the vascular areas. Figure 3 depicts all image processing procedures.

Figure 3.a shows the raw image , Figure 3.f shows the vessel region after it has been morphologically processed and converted to 1-bit.

a. b.

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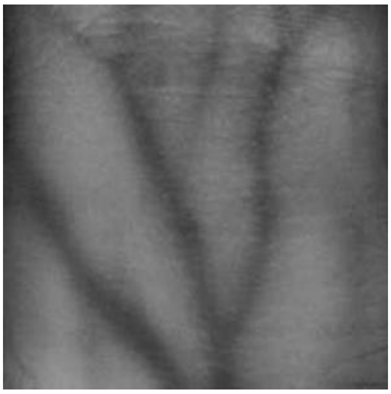
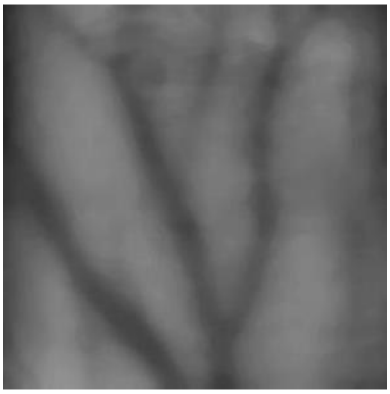


d.



c.

f.

e.

Figure 3. (a) Raw image (b) Gray level (c) KSAHE (d) Median (e) Adaptive thresholding (f) After morphological alterations

2.2 SURF Algorithms:

SURF- (Speeded-up Robust Features) [14].

$$H(x,\sigma)= \begin{pmatrix} Lxx\ (x,\sigma) Lxy\ (x,\sigma) \\ Lyx\ (x,\sigma)\ Lyy\ (x,\sigma) \end{pmatrix} \quad (1)$$

L is the Gaussian second order scale's derivation at X (x, y) in terms of and similarity for Lxy and Lxy. For classification, the function's maximum and minimum discriminant values are employed. The process of identification begins with the formation of a window around the identified feature point. The feature vector generated by the pixel in this region is computed. Figure 4 depicts the key point extraction procedure from the vascular area segmented and morphologically processed hand-wrist vein picture using the SURF approach.

Figure 4. SURF is used to extract key points.

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3. RESULTS

The SURF approach is used to find the important spots on the hand-wrist pictures as well as the descriptions for these locations. The same procedure is used for all items that come into contact with the camera throughout the subsequent identification process. The photographs in the database are matched by comparing the key points with the images in front of the camera. Figure 5 depicts an example matching procedure. The Euclidean distance technique between important locations is used in the matching procedure.

$$mesafe = \sqrt{(x(i) - (sütun + x_2(i)))^2 + (y(i) - y_2(i))^2} \quad (2)$$

In Equation(2), the process of calculating the pre-matching distances between two photos is completed. The point position of the points on the x-ye axes is shown in the equation x(i) and y(i) key on picture in database.

Figure 5 depicts an example matching procedure. Figure 5 (a) depicts the processed picture of the real-time image for the matching process, while (b) depicts the database wrist vein image of the same person. The person's hand-wrist photos are effectively matched.

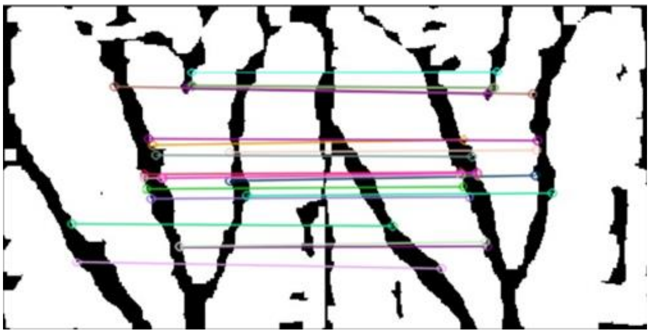

Figure 5. The SURF approach is used for matching. (a) Real-time image captured by the camera (b) Image stored in the database

As a consequence, the accuracy rate was determined to be 97% of the matching conducted on the segmented hand-wrist pictures as a result of the investigation. Each topic in the database of 100 persons took roughly 4 seconds to match.

4. DISCUSSION

The identification technique was carried out in the study using microcomputer-based hand-wrist vein pictures. Hand-wrist vein pictures gathered from 100 persons were transferred to the microcomputer environment and vascular areas were segmented by going through several image processing algorithms as a result of the study utilizing a Raspberry Pi infrared camera and a 3 B+ microprocessor. Images with visible vessel areas were fed into the SURF algorithm to extract local features. The extracted key points were saved in the database, and the matching procedure was subsequently done with the vein pictures in front of the camera.

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