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Biometric Technology Based on Hand Vein

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ABSTRACT

After fingerprints or iris digital, biometric identification of an individual can now be done through the veins of the hand. This technique uses a “palm vein scanner”: it is an optical sensor capable of “photographing” the palm vein using the “near infrared rays.” This technique uses a “palm vein scanner”.Biometric authenticationbyrecognition offinger veinorpalmis especially developed by Hitachi and Fujitsuin Japansince 2005. Compared to thetechnologyusingfingerprint recognition, it offers the advantage of beingsafer andit does not involveany physical contactwith the sensor.Vein recognitionis performed byremote effectoptically. This paper presents a survey of the biometric systems technology based hand vein.We first review the component modules including the algorithms they employ. Finally, a summary of the accuracy results reported in the literature is also provided.

Key words: Hand vein, palm, dorsal, finger, and biometric system.

INTRODUCTION

Blood loaded with oxygen comes into the hands through the arteries, and then again towards the heart through the veins. The oxygen depleted blood is not the same as the absorption filter arterial it absorbs light at wavelengths near infrared (about 760 microns).

When the hand is illuminated with infrared light, the vein appears black. It is recorded as an “identity card” in a database and can then be used for comparison during authentication.

There are two types of “photography”. Method “reflective” is more reliable than the transmission method (capture of light that passes through the hand). Indeed, when it is cold, the veins contract and the contrast is not quite visible transmission. For cons, the reflected light is not changed, and can use the same method reflective cold weather. On the other hand, the two parts of the device are in the same location, since the light is returned.

There is noway tocheat,because theycannot “shoot” the veins of thehand.The vascular network isunique to each individual: even identical twinsaredifferent.According to Fujitsu, which compared 140 000palms, TFA -False Acceptance Rate(people authenticated as some one else)is less than0.00008%. There isno

contactduring authenticationaswith fingerprints, so no hygiene problem. However, the method is stilltoo recent to beproperly assessed.Thescanneris relatively bulkycompared tofingerprint sensors.

As often noted in the literature, hand shape biometrics is attractive due to the following reasons:

1 We do not need to record photography: respect for privacy,called "traceless" [1-2].
2 Readersof biometricsvenous systemeven work withstained hands[3].
3 High level ofsecurity,to date nomeansto defraud[4-5].
4 FAR - False Acceptance Rate (people authenticated as someone else) is less than 0.001%[6-7].
5 Durable: Do not change in time, unlike the way or face or iris.

Operation of a hand veins-based biometric system

The biometric system has two purposes: authentication and identification.

Authentication or verification

It is better known amongst 1.1 [8], because it allows to certify (ensure) a claimed identity of the user[9].

Identification

It is better known one amongst N[8], since it allows users to determine which best fits the person to recognize. It adds the ability to check whether the user actually belongs to the database.

Based on the comparison result, the claimed identity is accepted or denied. The identification system includes the following modules: the sensor module, the feature extraction module, the matching module, the decision-making module and an optional template adaptation module.

The sensor module

In visible light, the veins are not apparent. Indeed, a multitude of other factors, including the surface characteristics such as moles, warts, scars, pigmentation and hair can also hide the image[9]. Fortunately, the use of the infrared light eliminates most unwanted surface features.

Required parameters to obtain good quality data are listed below[10-9].

1. The light affects the quality of the image obtained with the exception of no IR filter.
2. The temperature of the ambient environment must be neither too hot nor too cold, around the human body temperature.
3. The distance between the sensor and the object should be sufficient for a good acquisition.

Starting with Jackson W. Wegelinpatent[11], ncludes a dispenser controller coupled to a memory unit, which includes a database of previously-stored vein patterns. A vein-pattern sensor maintained by the dispenser images the unique vein pattern of a user's hand without contact. A recent study proposed using a three dimensional biometric scanner[1] for the capillary mapping of the palm of the hand[2] incorporates two image sensors[5,6] configured for obtaining a stereoscopic image of a vascular map and where for each image corresponding to each wave length, the depth of each point on the plane is known[12].Some multimodal biometric systems captureplamprint/ finger vein[15], hand geometry/ vein[16]. Other systems capture the palmar veins[13-14]. Based on On registering finger vein information, a hand photography camera 106 photographs an image in a state where a finger is set to a finger vein reader 102, and it is discriminated of which finger the finger vein information is to be registered, on the basis of the photographed image. There is too central combining several modalities as[17] which comprise a central command station (9) in signal communications (24a, 24b, 24c) with a series of blasting machines (16a, 16b, 16c). Command station[9] has a biometric analyser unit[10] and a authorizing means[11]. The blasting apparatuses have enhanced security features by including biometric analysis of specific biological features[13] of an authorized blast operator to generate a known biometric signature. The biometric signature can be derived from a fingerprint scan; a recognition scan of a hand, a foot, an iris or a retina; a skin spectroscopy analysis; a finger vein pattern analysis; a voice recognition analysis; or a DNA fingerprint analysis.

The feature extraction module

In order to segment, improve the quality of

Table 1:

Ref.	Dimensions	Thresholding	Binarization	Extraction des veines	Minutie's extraction	Classifi-cation	Number of dataset	Performance
[42]	160x120	Gaussian low pass & high pass	Local thresholding	Local thresholding	No	/	10.000	FAR 0.01%
[43]	Combinaison multiresolutions	Median	Local thresholding	Wavelettrans form	No	/	32	FRR 1.5% FAR 3.5%
[44]	Non mentionnée Gaussien	Median,	Local thresholding thresholding	Local	No Distance	Hausdorff	12 FRR 0%	FAR 0%
[45]	320x240	Median sholding	Iterativethre thresholding	Local	No registration	Rigid	50 FRR 3.00%	FAR 0.02%
[46]	320x240	Match filter, Filtre Wiener ,smoothing filter	Seuillage automatique	Quadraticinf erencefuncti on	No	Euclidean distance	200	FAR 0.02% FRR 0.03%
[47]	768 x576	Laplacian	Local thresholding	OTSU	Crossing number distance	Euclidean	100 FRR 1.14%	FAR 1.14%
[48]	320× 240	Match filter, Wiener threshold ,smoothing filter	Automaticthreshol ding	Cholesky decompositi on and Lanczos algorithm	No	Euclidean distance	200	FAR 0% FRR 0%
[49]	320 x 240	Median	Local thresholding thresholding	Local	Crossing number	Hausdorff Distancece	30	EER 3.68%
[50]	/ Median	Gaussien,	Local thresholding thresholding	Local	No distance	Euclidean	341	FRR 0.03%

[51]	/	Median	OTSU	Histogrameq ualization& Local thresholding	Crossing number	Triangulation des minuties		/	/
[52]	640x480	/	Local thresholding thresholding	Local			/	/	
[53]	/	/	/	Histogram equalization	Crossing number	Housdroff Distance	/	/	
[54]		Wiener , Median&morph ological operations	Local thresholding	Local thresholding	HOUGH Transformation	K Nearest Neighbor	20	/	
[55]	300×240	/	K-meanswith k=2	ICA Method	No measure	Cosinesi milarity	40 FAR 0%	FRR 20%	
[56]		Median, Gaussien high pass, low pass	Local thresholding	Local thresholding	No	Hausdorff Distance	/	/	

the image, extract veins from hand, we need some techniques:

Format conversion JPEG BMP

The conversation JPEG BMP is required. Indeed, the main advantage of BMP image quality is provided as BMP format is not compressed and therefore no loss of quality. Against by the JPEG format is compressed and therefore quality lost[18].

Enhancement

The resulting image may not contain noise as tasks, blobs, dust ... ect. Different filters can be applied to eliminate the noise and enhance the image, but if the pictures have a good quality, this step is not required[19]. In[20], the clearness of the vein pattern in the extracted ROI varies from image to image; they uses a 5x5 Median Filter to remove the speckling noise in the images and a 2-D Wiener filter to the ROI image to suppress the effect of high frequency noise[21]. Uses a various contrast enhancement techniques in order to compare which gives the best results, the study is very interest.

Converting the color image into a gray level

Converting a color image into a grayscale means that the image size will be reduced from 24 bits per pixel (color image) to 8 bits per pixel (grayscale image) [22-23]. Instead of having three matrices that represent the level of colors (red, green, blue) for each pixel, we have just a single matrix that represents the gray level for each pixel, which reduces the processing time[24-25].

Binarization

Binarization is the segmenting the image into two levels; object (hand region) and background; most of the time the object segment which is the region of interest (ROI) in white and the background segment in black[26-28].

Feature extraction

After the binarization, there is the most difficult step which is the feature extraction. Some researchers add a step in this module[29-32]. Some works uses the minutiae features extracted from the vein patterns for recognition, which include bifurcation points, ending points and the position and orientation of minutiae points[33,35,36,37]. Uses it with the vein finger, when [34] uses it with the dorsal hand vein. In[38] the feature extraction was based on the geometry veins.

The figure below shows these minutiae (playback direction: from left to right).

We can call it too Identification/Authetication phase or then Verification. The image of the veins that was extracted in the previous phase allow us to create a database of prototypes with (s) models that are in the base (template) byAuthenticating the identity of an undividual, will either accept the person, or reject it. Instead of the identification, the system will identify the right person. In order to evaluate theirsystem testing performance[39], uses a dataset of 500 persons of different ages above 16 and of different gender, each has 10 images per person was acquired at different intervals, 5 images for left hand and 5 images for right hand. [40] used correlation and template matching as a recognition algorithm whether[41] used Using Principle Component Analysis (PCA).

Survey : biometrics dorsal veins

This last year's many works has been made on the dorsal veins, the table below give the several techniques that has been used for each biometric step.

Thresholding (removing noise)

In [42], they used the low pass Gaussian filter (3 * 3) and high pass (11 * 11) to obtain a good image vein patterns. Others have preferred to use the Median filter (5 * 5) instead of Gaussian[43,45,49] in the case of [45] the Gaussian filter remove some needed edges, as an alternative the Median filter that conserves the edges[49].

On the other hand, [44,42,57] used the two filters: low pass Gaussian components to reduce the image having a high frequency (dark pixels) and Median (5 * 5) to remove speckles (the small jobs that appear in the image texture). Another technique has been adapted in[58]; the ridgelet transform in order to eliminate noise and highlight the veins.

In [48],they used Match filter, Wiener filter, smoothing filter to eliminate noise and get clear veins.

Table 2: Survey: the palm vein biometrics

References	Dimensions	Thres holding	Binarization	Vein extraction	Minutie Exctraction	Classification	Nbr of individu	Perfor-mance
[61]	/	GSZ -shock	No	Gaborthres holding	Cross-number distance	K-NN with Euclidian	/	/
[62]	640x320	Gaussian Lowpass	SIFT	SIFT	Not done	Euclidian Distance	24	EER=0%
[63]	768×576	GaussianHigh pass	/	Morphological operations	Not done	Correlation coefficient	100	/
[64]	/	Gaussian	Thresholding multiscale		Not done	Method TOH & al[35]	/	/

Table 3:Survey : finger vein biometrics

References	Dimensions	Thres holding	Binarization	Vein extraction	Minutie Exctraction	Classification	Nbr of individu	Perfor-mance
[66]	180*160 150*150 120*40	/	/	[38][39][40]	/	/	/	More details in[37]
[67]	640×480	Median (5*5), SpecialMedian (3*3)	Threshold=0	Squelettisation	/	/	/	/
[68]	240 x 180	Gaussian, Median,(7*7), Iterativeconnected componentslabeling	Local thresholding	Local thresholding	/	[43][44]	100	0% FAR 0.27% FRR
[69]	/	/	Mask binary pattern	SVM and local	/ Distance	Hanming	/	/EER 0.049%

Binarization

Several techniques exist for the binarization. Indeed[42-45,47,48,56],used a local thresholding based on the neighboring pixels, as it gives better results compared to theglobal threshold[8,11] have used another type of automatic thresholding is OTSU, for it requires shortprocessing time[59].One more method of binarization, is the K-means which was applied with k = 2 (the bottom and hand)[55].

Feature extraction

Some researchers divide this module in two steps extraction veins then extracting minutiae; sometimes we can found onlyfeature vein's extraction.

Extraction veins

The local thresholdinggives good results; for that it is very used in particular in[30,42,44,45,50,51,52,53,56,43]. Applied the wavelet transformation to locate veins. Others used a quadratic function[46], for the reason that it has as main advantage reducing the size of the matrix; which has a direct impact on the processing time classification[46-47]. Used OTSU method which has been widely used for the document's binarization; it often gives the best results and the fast[20]. UsedCholesky decomposition and Lanczos algorithm to reduce the processing time. When,[53] based on anhistogram equalization;this makes dark pixels appear darker and bright pixels appear brighter. To get the right threshold from the histogram.

.

Extraction of minutiae

Crossing number used to extract more properties on the veins[29,30,60,28]. used Hough transform to isolate the end points that will be used afterwards for classification[54].

Classification

To compare the shape of the extracted veins (s) size (s) of reference[44,56,31,30] used the Hausdorff distance, the test results showed that all the vein pattern images in the database have been correctly recognized[44,46,47,50]. Used Euclidean distance, the error rate of FAR and FRR was still reduced.

Others[51] have used the method of minutiae triangulation, which can form triangles from minutiae (bifurcation points and end points). Then a score is generated by computing the number of triplets bifurcation and end points of the input image, and compared with the number of the triplets and end points that are stored in the database. Another technique was used, the rigid registration[51], which

showed that the right hand and the left hand of the same person are not identical. 4.3.1. Survey : palm vein biometrics

In the followed table, we quote some works that have been studiedaround the palm veins. The boxes marked with / want to say that the technique was not mentioned in references

In[61], the filter-GSZ shock was used to eliminate noise and improve contours[62-63]. Used the Gaussian filter to correct the contrast of the image[63] used the Gaussian filter for high pass intensity improvement.

In[61], they based on the Gabor filter to extract the characteristics of the hand in the form of texture. Others have preferred to use a local thresholding"SIFT". In[62] extract the hand and palm vein doing like[65], and showed the effectiveness of this method for binarization. Another technique, which is the multi-level thresholding was applied in[64].

In[61], they used the Gabor filter to extract the veins, then they made a skeletonization to better visualize the veins.

In[61], they used K-NN to classify individuals where[63] used another technique which is the correlation coefficient; it is widely used in image processing. By cons[64] adopted the method of TOH et al in[66].

Enhancement

Used a filter oriented to improve the image[46]. In[67], the median filter (5 * 5) was used to improve the image quality. Median filter and another Special (3 * 3) was applied after the detection of finger vein to eliminate all single points (unwanted noise in the background) from the image[67]. In[68], they used the Gaussian filter to eliminate noise such as dust, the median filter for image binarization, and an

iterative labeling connected components because the picture still contains points not belonging to the finger vein.

Binarization

In[67], a threshold (= 0) was set to extract to the bottom. In[68], they preferred to use an automatic thresholding, which gives good results, based on the pixel neighbors (more details are in[67]). Applied a mask in order to detect the edges of the finger, and they reduced the size of the image taking area of the finger[69].

VeinExtraction

To extract finger vein, three algorithms were applied in[66] are in[38-40] respectively; whose

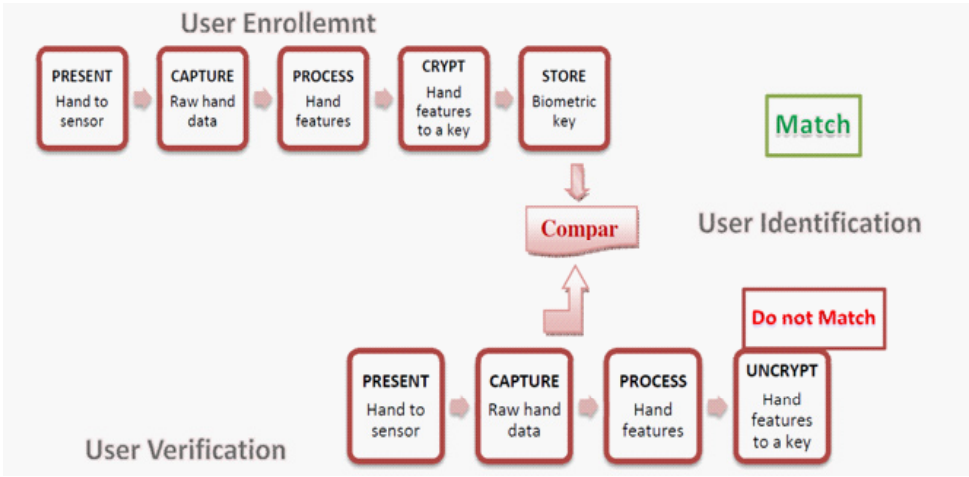

Fig. 1: Processing steps in an identity verification system using hand vein

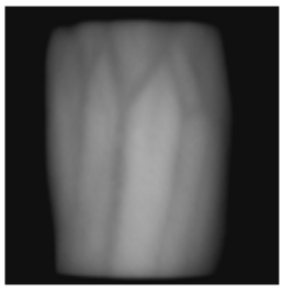

Fig. I. Three dorsal veins

Fig. 4 palmar veins

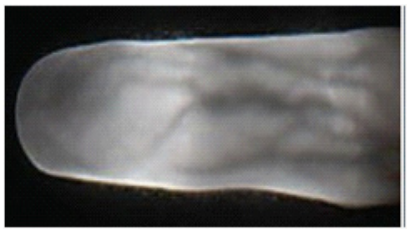

Fig. I. Five finger veins

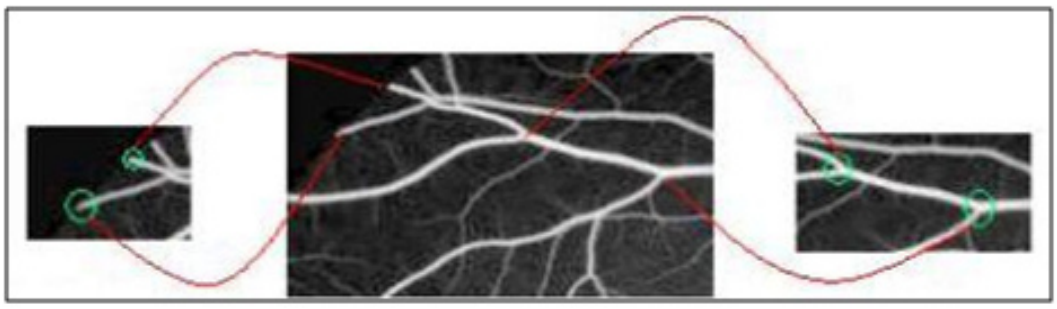

Fig. I. 6: End Points, veins branching points[33]

goal is to apply the methods used in fingerprint to extract finger vein[66] and see what happens. So, by combining several resolutions, the algorithm used in[38] gave stable results for the FAR and FRR. In[41], they made the veins in the form of a skeleton using a fairly simple and effective.

Found that the finger veins are not always clear, so the solution is to use the local binary pattern, because it is a very robust method. Then they[45] classified the code that has been obtained by this method into three categories: LA (Large amount), MA (Medieum amount) and SA (Small amount) using SVM.La figure below shows it. Also, in[45] they deduced that the minutiae extraction step is not necessary, it takes a lot more time in treatment. So they have to add this step.

Classification

In[67] used the methods found in[43-44]. By cons[69] used the Hamming distance based on the LBP code has been extracted in the extraction phase characteristics are.

CONCLUSION

In a biometric system, two important criteria to consider: the accuracy of results and processing time. It is for this reason that this chapter has presented a state of the art biometrics veins of the hand, to discover different algorithms and study them in detail in the chapters that come after, starting from the second step is preprocessing to the classification, which aims to identify people by the dorsal veins of the hand.

Indeed, the most important operation in the preprocessing module is the binarization. Several techniques existbinarization, but to choose a single technique that meets these two criteria, a state of the art must be done in order to know the complexity of each algorithm and the quality of the results provided.

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