A NOVEL TECHNIQUE FOR FINGER-VEIN FEATURE EXTRACTION AND AUTHENTICATION

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Abstract - The increasing use of biometric authentication systems in the recent years, makes spoof fingerprint detection an increasingly important thing. Normally people use this biometric finger print authentication using various techniques. But this finger print can be forged using silicon or gelatin gel so to overcome this problem a Finger vein recognition technique is proposed. It is a method of biometric authentication that uses pattern recognition techniques based on images of human finger vein patterns beneath the skin's surface. Finger vein recognition is one of many forms of biometrics used to identify individuals and verify their identity. Finger Vein ID is a biometric authentication system that matches the vascular pattern in an individual’s finger to previously obtain data. The technology is currently in use or development for a wide variety of applications, including credit card authentication, automobile security, employee time and attendance tracking, computer and network authentication, end point security and automated teller machines. The demand for simple, convenient, and high security authentication systems for protecting private information’s stored in mobile devices has steadily increased with the development of consumer electronics. The personal information’s can be protected in the form of biometrics which uses human physiological or behavioural features for personal identification.

Keywords –Local Binary Patterns, Support Vector Machine, Region Of Interest ,Vein, Authentication.

1. INTRODUCTION

Most image-processing techniques involve treating the image as a dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing is also possible. The acquisition of images (producing the input image in the first place) is referred to as imaging. Image processing allows one to enhance image features of interest while attenuating detail irrelevant to a given application, and then extract useful information about the scene from the enhanced image. This introduction is a practical guide to the challenges, and the hardware and algorithms used to meet them.

Finger vein recognition is a method of biometric authentication that uses pattern-recognition techniques based on images of human finger vein patterns beneath the skin's surface

1.1 Finger Vein Recording Process : In Fig 1.1 the recording Process is shown. To obtain the pattern for the database record, an individual inserts a finger into a attester terminal containing a near-infrared Light Emitting Diode (LED) light and a monochrome Charge-Coupled Device (CCD) camera. The hemoglobin in the blood absorbs near-infrared LED light, which makes the vein system appear as a dark pattern of lines. The camera records the image and the raw data is digitized, certified and sent to a database of registered images. For authentication purposes, the finger is scanned as before and the data is sent to the database of registered images for comparison.

Fig. 1.1 Finger Vein Recognition
1.2 Multimodal Biometric Authentication Based On Score Level Fusion Of Finger Biometrics: Jialiang Peng et al [1] [14] [15] presented Multimodal biometric authentication based on score level fusion of finger biometrics. In biometric system, unimodal biometric systems have been proven their superior performance to adapt the increasing demand of accurate and efficient identification in such a rapid developing society. However, unimodal biometric systems have several inherent problems such as large intra-class variations, non-universality, and spoofing attacks and In addition, the performances of unimodal biometric system are seriously affected by the conditions of the users health, illumination, type of sensor, etc. and. Multimodal biometrics, which is able to effectively overcome most of the above weaknesses in unimodal biometric systems, is attracting the attention of many researchers in multifaceted disciplines and. Its performance is superior to unimodal biometric systems such as higher accuracy, noise resistance, universality, anti-spoofing attacks, and more robust than unimodal ones. Multimodal biometric scores are fused by the t-norms, which do not require any learning or training with less computational complexity. The disadvantage of this method is that it works in the matching score space only

2.2 Vascular Pattern of the finger: Biometric of the future :B.Ton [2] presented the vascular pattern of the finger is advertised as a promising new biometric, characterized by very low error rates, good spoofing resistance and a user convenience that is equivalent to that of fingerprint recognition. This new form of biometrics has been gaining increasing attention since the year 2000. At present Hitachi has a monopoly position on this new type of biometrics. As a result there are only few and small publicly available datasets and only little academic research has been done in order to verify published claims on performance. Vascular recognition is Invasive because it creates apprehension amongst users that it can be a painful process.

2.3 Human Identification using Finger Images: Ajay Kumar et al [3] presented a new approach to improve the performance of fingerprint identification systems. The proposed system simultaneously acquires the finger vein and low resolution fingerprint images and combines these two evidences using a novel score level combination strategy. The utility of lower solution fingerprint images acquired from a webcam is examined to ascertain the matching performance from such images. The user develops and investigate two new score level combinations, i.e., holistic and nonlinear fusion, and comparatively evaluate them with more popular score level fusion approaches to ascertain their effectiveness in proposed system. The rigorous experimental results presented on the database of 6,264 images from 156 subjects illustrate significant improvement in the performance, both from the authentication and recognition experiments.

2.4 A GSA-based Method in Human Identification Using Finger Vein Patterns: Fateme Saadat et al [8] [4] presented a new multi biometric system for human authentication. The proposed method used patterns of three different finger veins and fused them using score level fusion strategy. Biometric and multi-biometric sciences play an important role in human authentication systems nowadays. Finger vein pattern is one of the most reliable and secure biometrics due to its invariability and safety from stealth. In this paper, a heuristic method is proposed for score level fusion of three different finger vein’s patterns. In the proposed multi-biometric system, Gravitational search Algorithm is used to tune the weights of sum fusion strategy. The performance of the method is evaluated using FAR, FRR and EER criteria. Experimental results confirm the superiority of the proposed method over classic fusion strategy in human identification.

2 EXISTING SYSTEM

Fingerprint liveness detection algorithms can be broadly divided into two approaches: hardware and software. In the hardware approach, a specific device is added to the sensor in order to detect particular properties of a living trait such as blood pressure skin distortion. In the software approach, which is used in this study, fake traits are detected once the sample has been acquired with a standard sensor. There is a long list of available biometric patterns, and many such systems have been developed and implemented, including those for the face, iris, fingerprint, palm print, hand shape, voice, signature, and gait. Not with standing this great and increasing variety of biometrics patterns, no biometric has yet been developed that is perfectly reliable or secure.

3. PROPOSED SYSTEM

The finger-vein is a promising biometric pattern for personal identification in terms of its security and convenience. It is difficult to steal since the vein is hidden inside the body and is mostly invisible to human eyes. The non-invasive and contactless capture of finger-veins ensures both convenience and hygiene for the user, and is thus more acceptable The finger-vein pattern can only be taken from a live body. For more accuracy and speed we use LHS technique which can be abbreviated as LBP (Local Binary Pattern), Haar wavelet and SVM (support vector machine) for the various modules like feature extraction and classification.
3.1 PROPOSED ARCHITECTURE:

The proposed system consists of the following modules: Segmentation, Feature Extraction, and Classification. These are the modules that are used to detect the finger vein authentication and the architecture diagram is shown below in Fig 1.2 and the all Modules are explained further in detail.

Fig 1.2 Finger Vein Authentication Architecture

4. SEGMENTATION

Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

4.1 REGION EXTRACTION: The extraction is done using the region extraction method in order to implement a high performance system, an important step is to localize the region of interest accurately. A problem in previous ROI localization methods is that some useful finger vein information is lost in the final cropped ROI region. In order to resolve this problem, a novel ROI extraction method for finger vein images is proposed. Finger edges are detected and adjusted to the horizontal direction, after that a modified sliding window is used in order to detect the distal inter-joint line of the finger. On the basis of the edges and the distal inter-phalangeal joint line of the finger, different from previous methods, an outer rectangle is used to crop the finger area to avoid the useful information loss.

4.2 MAX CURVATURE: This section describes our algorithm for extracting finger-vein patterns from finger images. This algorithm consists of three steps.

4.2.1 EXTRACTION OF THE CENTRE POSITIONS OF VEINS: To extract the centre line of veins with various widths and brightness, our method checks cross-sectional profiles of a finger-vein image. The cross sectional profile of a vein looks like a dent because the vein is darker than the surrounding area, as shown in Fig. 1.3. These concave curve shave large curvatures. Even if narrow/wide or bright/dark veins are shown in an image (positions A, B, and C in Fig. 5.1) and the centre position of veins do not have a local minimum brightness (position C), the curvature of the profiles of the veins are large. Therefore, the centre position of veins can be obtained by calculating local maximum curvatures in cross-sectional profiles. The procedure for extracting vein centre lines is shown in Fig.1.4. To make feature extraction robust against vein width fluctuation, only the positions of the centre lines of veins are emphasized. A score is assigned to each position, and it is larger when its dent is deeper or wider.

The details are described below.

Fig.1.3 Cross-sectional profile of veins

Step 1. Calculation of the curvatures of profiles:
Step 2. Detection of the centres of veins:

Fig.1.4 Relationship among profile, curvature, and probability score of veins.
Step 3. Assignment of scores to the centre positions:
Step 4. Calculation of all the profiles:

4.2.3 Labeling the image: The vein pattern, G(x,y), is binarized by using a threshold. Pixels with values smaller than the threshold are labelled as parts of the background, and those with values greater than or equal to the threshold are labelled as parts of the vein region. We determined the threshold such that the dispersion between the groups of values in G(x,y) was maximized, assuming that the histogram of values in G(x,y) was diphasic in form. An example of vein pattern extraction is shown in Fig 1.5.

![Original Image and Extracted Pattern](image)

Fig.1.5 Result of vein extraction

5.FEATURE EXTRACTION

Feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. When the input data to an algorithm is too large to be processed and it is suspected to be redundant then it can be transformed into a reduced set of features. Determining a subset of the initial features is called feature selection. The selected features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of the complete initial data. Here for the finger vein detection the Feature Extraction is done using LBP(Local Binary Patterns) and haar wavelet.

5.1 LOCAL BINARY PATTERNS : Local binary patterns (LBP) is a type of visual descriptor used for classification in computer vision. LBP is the particular case of the Texture Spectrum model proposed in 1990. LBP was first described in 1994. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. A comparison of several improvements of the original LBP in the field of background subtraction was made in 2015 by Silva et al. A full survey of the different versions of LBP can be found in Bouwmans et al.

The LBP feature vector, in its simplest form, is created in the following manner: Divide the examined window into cells (e.g. 16x16 pixels for each cell). For each pixel in a cell, compare the pixel to each of its 8 neighbors (on its left-top, left-middle, left-bottom, right-top, etc.). Follow the pixels along a circle, i.e. clockwise or counter-clockwise. Where the center pixel's value is greater than the neighbor's value, write "0". Otherwise, write "1". This gives an 8-digit binary number (which is usually converted to decimal for convenience). Compute the histogram, over the cell, of the frequency of each "number" occurring (i.e., each combination of which pixels are smaller and which are greater than the center). This histogram can be seen as a 256-dimensional feature vector. Optionally normalize the histogram. Concatenate (normalized) histograms of all cells. This gives a feature vector for the entire window. The feature vector can now be processed using the Support vector machine or some other machine-learning algorithm to classify images. Such classifiers can be used for face recognition or texture analysis. Using uniform patterns, the length of the feature vector for a single cell reduces from 256 to 59.

5.2 HAAR WAVELET : The Haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. Wavelet analysis is similar to Fourier analysis in that it allows a target function over an interval to be represented in terms of an orthonormal basis. The Haar sequence is now recognised as the first known wavelet basis and extensively used as a teaching example. The Haar sequence was proposed in 1909 by Alfréd Haar. Haar used these functions to give an example of an orthonormal system for the space of square-integrable functions on the unit interval. The study of wavelets, and even the term "wavelet", did not come until much later. As a special case of the Daubechies wavelet, the Haar wavelet is also known as Db1. The Haar wavelet is also the simplest possible wavelet. The technical disadvantage of the Haar wavelet is that it is not continuous, and therefore not differentiable.

The attracting features of the Haar wavelet transform, including fast implementation and able to analyse the local feature by determining the location of low frequency area and high frequency area, considering that the Haar functions are the simplest wavelets for signal and image compression and feature extraction. Wavelet moment is an invariant descriptor for image features. A wavelet moment feature is invariant to image rotation, translation and scaling so it is successfully applied in the pattern recognition, and is applied as in the following steps:
Step 1: Divide the vein image into blocks with overlapping to overcome the variation in the image captured for the same person due to positioning during the image capture process. The value of overlapping length is taken as a ratio of block length. Main block Overlapped block

Step 2: For each divided block apply 2-D wavelet transform, which decompose it into four sub-images, as is indicated in Fig. 1.7 where LL represents an approximate low frequency vectors, HL represents high frequency vectors in horizontal direction, LH represents high frequency vectors in vertical direction, HH represents diagonal high frequency vectors.

Step 3: For each sub band belongs to the block image, the energy of wavelet is computed by using the following equation:

\[ \sum_{x=x-s}^{x-e} \sum_{y=y-s}^{y-e} \text{wavelet}(i,j)^2 \]

Where \((xs, ys)\) are the range of coordinates of the tested block image, \(\text{wavelet}(i, j)\) is the wavelet sub bands.

6. CLASSIFICATION

The classification is done using the Support Vector Machine (SVM). SVM are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.

6.1 Support Vector Machine: A Support Vector Machine (SVM) is a discriminative classifier formally defined by a separating hyperplane. In other words, given labeled training data the algorithm outputs an optimal hyperplane. For a linearly separable set of 2D-points which belong to one of two classes, find a separating straight line.

In Fig.1.10 there exist multiple lines that offer a solution to the problem to estimate the worth of the lines. A line is bad if it passes too close to the points because it will be noise sensitive and it will not generalize correctly. Therefore, it is to find the line passing as far as possible from all points. Then, the operation of the SVM algorithm is based on finding the hyperplane that gives the largest minimum distance to the training examples. Twice, this distance receives the important name of margin within SVM’s theory. Therefore, the optimal separating hyperplane maximizes the margin of the training data.
6.2 Image Classification: Image classification refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. Depending on the interaction between the analyst and the computer during classification, there are two types of classification: supervised and unsupervised. The recommended way to perform classification and multivariate analysis is through the Image Classification toolbar.

6.2.1 Supervised Classification: Supervised classification uses the spectral signatures obtained from training samples to classify an image. With the assistance of the Image Classification toolbar, you can easily create training samples to represent the classes you want to extract. You can also easily create a signature file from the training samples, which is then used by the multivariate classification tools to classify the image.

6.2.2 Unsupervised Classification: Unsupervised classification finds spectral classes (or clusters) in a multiband image without the analyst’s intervention. The Image Classification toolbar aids in unsupervised classification by providing access to the tools to create the clusters, capability to analyze the quality of the clusters, and access to classification tools.

7. ADVANTAGES OF FINGER VEIN TECHNOLOGY

7.1 Accurate: Rates for acceptance of false users or rejection of true users are among the lowest for biometric technologies, making finger vein authentication a reliable security solution. Unique vein patterns plus leading-edge technology means high accuracy rates. Small amount of data is required (400 bytes), allowing fast authentication (< 1 second) and increased portability.

7.2 Fast: Vein pattern matching is completed within the blink of an eye, affording users a speedy authentication experience without the hassle and without the wait. Secure

As finger vein patterns are found internally within the body, forgery is extremely difficult. Dryness or roughness on the surface of the skin also has no effect on the accuracy of vein pattern authentication.

7.3 Small: Finger vein authentication devices are compact and therefore applicable as embedded devices in a variety of applications.

7.4 Non Traceable: Veins are inside the body, invisible to the eye, and not accessible. Therefore, it is extremely difficult to forge and impossible to manipulate. The use of light transmission to gather biometric data means that the condition of the skin surface does not affect accurate processing.

7.5 User-Friendly: The vein patterns of each finger are unique, so each individual can register multiple fingers as "back-up" for authentication purposes. Registration is possible even for sweaty, oily or dirty fingers.

7.6 Disadvantage:

- Not easy to implement.
- Device cost is expensive.

8. CONCLUSION

The present study proposed an finger-vein recognition with LBP algorithm and Haar wavelet transform in feature extraction method. The images from several fingers is taken from the database and we got the output whether the finger-vein is authorized or unauthorized. In this paper we have discussed the unique characteristics of finger vein authentication technology as well as its future development. With this system a single person can make a secure lock to his system and no other person can access without his knowledge. As society becomes more information-oriented and more globalized, the importance of security technologies in a variety of sectors will continue to grow steadily. The advantages of finger vein authentication in accuracy and ease of use depends considerably on microcomputers, image sensors and other such semiconductor devices, and thus there is great hope placed in the advancement of semiconductor technologies.

REFERENCES


