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Deep Representation Based Feature Extraction and Recovering for Finger-Vein Verification

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ABSTRACT: This project proposes a finger vein authentication Biometrics is the science of identifying a person using physiological or behavioral features. These features range from physical traits like fingerprints, faces, retina etc. to personal behaviors such as signatures. Compared to traditional methods, biometric features are much harder for intruders to copy or forge, and it is very rare for them to be lost. Identification system makes use of the biometric features, offer more security and reliability. However, verification using vein patterns is less developed compared to other human traits. We proposed the feature extraction of the finger vein pattern of the hand using the contact-less sensors. Vein pattern identification uses an infrared light source to scan for hemoglobin within the blood. Once the user's hand is kept over a sensing device, a near infrared light from the sensing device maps the position of the veins. Deoxygenated hemoglobin flowing in the veins absorbs these infrared rays and show up on the map as dark lines. The finger of the hand has more complex vascular patterns and provides a lot of distinct features. The steps involved in this process are image enhancement, skeletonization and chain code comparison of the vein pattern.

I. INTRODUCTION

Intended to be a robust approach for liveness detection in fingerprint and hand geometry systems, vein recognition evolved to an independent biometric modality over the last decade. Classically the capturing process can be categorized in near and far infrared approaches. Vein recognition systems based on the near infrared approach are exploiting differences in the light absorption properties of the de-oxygenated blood flowing in the subcutaneous blood vessels and the surrounding tissue. Vein become visible as dark tubular structures. They absorb higher quantities of the infrared light emitted by the LED of the sensor, than the surrounding tissue. Alternatively in the far infrared approach the heat radiation of the body can be measured. Because of the temperature of blood is typically higher than the temperature of the surrounding tissue, the temperature gradient between the blood vessels and the tissue can be measured in this spectrum. Additionally, vein scanners are contact less, hence they are considered to be more hygienic than systems requiring direct physical contact.

BIOMETRICS

Biometrics (or biometric authentication) refers to the identification of humans by their characteristics or traits. Biometrics is used in computer science as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance.Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals. Biometric identifiers are often categorized as physiological versus behavioral characteristics. Physiological characteristics are related to the shape of the body. Examples include fingerprint, face recognition, DNA, Palm print, hand geometry, iris recognition, retina and odour/scent. Behavioral characteristics are related to the pattern of behavior of a person, including typing rhythm, gait, and voice.

BIOMETRIC FUNCTIONALITY

Many different aspects of human physiology, chemistry or behavior can be used for biometric authentication. The selection of a particular biometric for use in a specific application involves a weighting of several factors. Universality means that every person using a system should possess the trait. Uniqueness means the trait should be sufficiently different for individuals in the relevant population such that they can be distinguished from one another. Measurability (collectability) relates to the ease of acquisition or measurement of the trait. In addition, acquired data should be in a form that permits subsequent processing and extraction of the relevant feature sets. The latter function can only be

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achieved through biometrics since other methods of personal recognition such as passwords, PINs or keys are ineffective.

FINGER VEIN RECOGNITION

Biometrics, such as with vein recognition, refers to methods for recognizing individual people based on unique physical and behavioral traits. Vein recognition is a type of biometrics that can be used to identify individuals based on the vein patterns in the human finger.Vein recognition is a fairly recent technological advance in the field of biometrics. It is used in atms,banking, law enforcement, military facilities and other applications that require very high levels of security. The ID verification process is very fast and contact-less. Using a light-transmission technique, the structure of the vein pattern can be detected, captured and subsequently verified. One reason that vein recognition has such great potential for explosive growth. There are a variety of methods for vein recognition biometric technology. Some companies have developed devices that scan the vein structure pattern in the index finger, or more than one finger at a time. Others have developed vein recognition devices designed for reading the vein patterns located under the palm and at the back of the hand. The variety of devices available gives a wide selection of choices for consumers to meet different needs and demands.

II. LITERATURE SURVEY

Dorsal Hand Vein Image Contrast Enhancement Techniques

This paper deals with the concept of contrast enhancement and study about various techniques applied on image enhancement. The techniques histogram equalization and contrast limited adaptive histogram equalization are used to enhance the contrast of the image

An analysis of thinning and skeletonization for shape

This paper deals with the analysis of thinning and skeletonization methods for shape representation. It deals with the skeletonization of an image, need for skeletonization and explains how thinning algorithm is used for extracting the skeletons from an image.

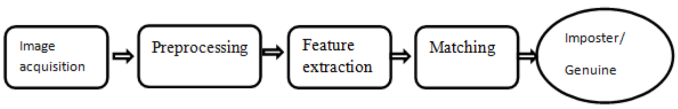
A New Skeletonization Method Based on Connected ComponentApproach

The present paper presents a novel scheme for thinning, using connected component approach. One of the disadvantages of the existing morphological thinning method is that it is not automatic. It always requires humaninteraction to detect the good skeleton, and then by stopping the iterative process. The novelty of the present paper is that it always measures the value of the connected components by which the proposed method makes the algorithm as automatic. The present scheme is applied on English alphabets which possess different structures and shapes, and good results are obtained.

III. METHODOLOGIES USED FOR MULTIMODAL BIOMETRIC SYSTEM

3.1 Authentication using finger vein recognition based on Matlab

This project aims at developing a system for acquiring images of finger veins and processing them using **MATLAB** for the purpose of **authentication**. It includes designing of hardware for image acquisition, coding the matching algorithm for processing the finger vein pattern and training and testing of algorithm module. Typical Finger vein recognition system consists of **image acquisition module**, **image preprocessing**, **feature extraction**, and **matching**.



3.2 Image acquisition:

Finger Vein patterns can be viewed through an image sensor sensitive to infrared light. Infrared light passing through the tissues of the human body is blocked by hemoglobin. As hemoglobin exists densely in blood vessels, infrared light passing through veins appears as dark shadow lines in the captured image

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3.3 Pre-processing

The first step of the proposed multimodal biometric recognition is pre-processing which makes the input training images better suitable for the subsequent steps. The important processes such as, normalisation, filtering and resizing

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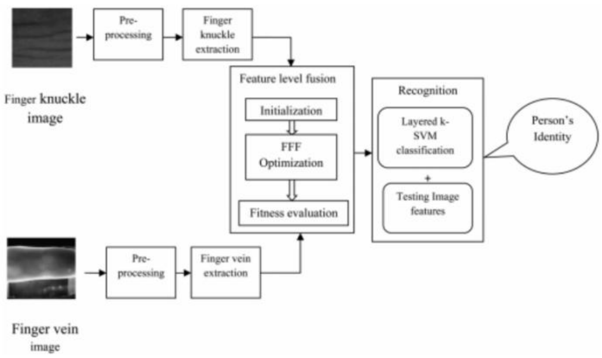
are carried out under pre-processing steps. Once the input images are read out, it undergoes the normalisation steps to convert the range of pixels within the particular range. The, median filtering is applied to smooth the input images which makes the input images much visible. Also, this process is helpful for the feature extraction to easily identify the vein parts. Then, resizing is performed to convert all the input images into fixed size through interpolation scheme.
Preprocessing step includes **image segmentation** in which captured image is divided into multiple parts. Each of the **pixels** in a segment will be similar with respect to some properties, such as color, texture or intensity. The aim of segmentation is to change the representation of an image into something that is easier to analyze. Image segmentation is used to locate objects and boundaries in an image. Segmentation is the process by which we are assigning a label to every pixel in an image. Pixels sharing the same label will have certain similar visual characteristics.

3.4 Vein and knuckle print extraction using repeated line tracking

In this section, the extraction of finger knuckle and vein print using a repeated line method is discussed [20]. The line tracking operation starts at any pixel in the source image. We defined the current pixel position in an image as the current tracking point and this point is moved from pixel to pixel along the dark line direction in the finger knuckle and finger vein images. Thus, the method of feature extraction from the image is described as follows. F i, j is the intensity of the pixel i, j in the finger nuckle image. Similarly, F m, n is the intensity of the pixel m, n in the finger vein image. Zfk and Zfv are the set of pixels in the finger knuckle and finger vein images, respectively. Sl is considered as the locus space. Thus, the knuckle and vein print are extracted by the following four steps:
The **finger vein** image features are extracted using wavelet transform and line detection. **Wavelet transform** is a mathematical function which divides a function into its different frequency components .Wavelet transform analyzes each individual component with a resolution that matches its scale. HAAR wavelet transform multiplies a function against the HAAR wavelet with various shifts and stretches. **HAAR** transform is easy to implement and is able to analyze the local features. These characteristics make HAAR wavelets applicable for Finger vein recognition algorithm.



At last, matching with database is a final decision making step to get a result from the finger vein recognition algorithm. In the matching stage two types of errors are considered **FAR** (False Acceptance Rate), **FRR** (False Rejection Rate). FRR is the rate of occurrence of a scenario in which two fingerprints from same finger fails to match (the matching score is below the threshold) while FAR is the rate of occurrence of a scenario in which two fingerprints from different fingers will match (matching score is greater than the threshold). **EER** is the error rate at which the FAR equals the FRR and is therefore, suitable for measuring the overall performance of biometric recognition system.
Sample image and its feature extracted image are shown below.

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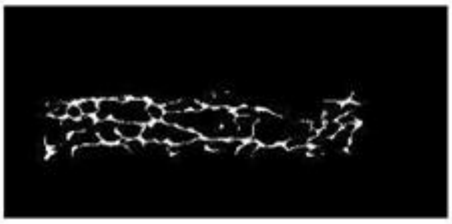
Sample finger vein image.

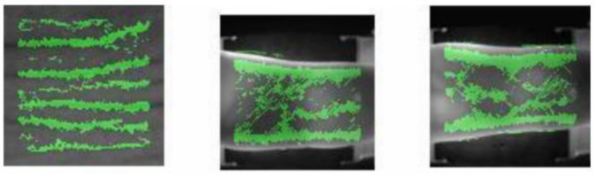


Feature extracted image

In the verification stage, newly captured finger vein image is applied to preprocessing stages, and at last vein image is replaced with the feature extracted image. Finally that extracted image is sent to an authentication stage. This stage will match the newly feature extracted image with the database image, after matching it will create a match score of each finger vein images in the database. Depending on the match score authentication is carried out. This project implements a highly secured authentication system based on using finger vein recognition.

3.5 Feature-level fusion by FFF optimization

Fusion at the feature level is least explored even though they are expected to provide better recognition results and much easier to compute. The matching score-level and decision-level supplies less information to be exploited for personnel authentication than the feature-extraction level. Also, the feature-level fusion carries much richer information about the raw biometric data than the matching score or decision level. This is the driving force for the proposed scheme.



a b c

3.6 Recognition using layered k-SVM classifier

The extracted features of finger knuckle and finger vein are fused by the FFF optimization. Then, the classification is performed using layered k-SVM classifier. Here, SVM classifier and k-NN classifier are combined to perform binary classification and then, $N - 1$ k-SVM classifiers are connected serially to perform multi-level classification. Here, SVM classifier is a binary classifier which is classified by either 0 or 1. Similarly, k-NN classifier is popular technique for data classification based on the neighbors of the input test data. The reason of selecting the k-NN classifier is that it can perform better for multi-classification because the classification is purely based on the distance between the training data and test sample. Also, SVM is preferably chosen here because of the good performance for the high dimensional data. In proposed work, we used an N number of persons for biometric recognition. Thus, recognition is done by the layered k-SVM classifier which consists of $N - 1$ number of classifiers.

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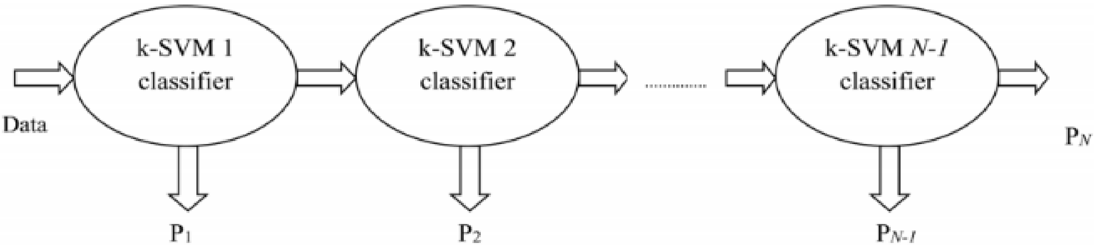

Table1: Comparison table on the literature survey

IV. RESULT AND DESCRIPTION

4.1 RESULT

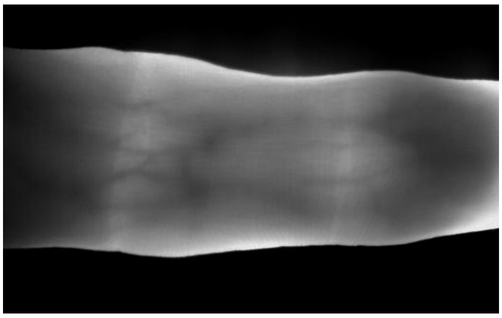

Fig Input vein image

Figure is the finger vein image obtained from SDUMLA –HMT database which is given as the input to the contrast enhancement block. It produces enhanced image using Contrast Limited Adaptive Histogram Equilization. CLAHE can make the image into contrast enhanced image by computing cumulative distributive function.

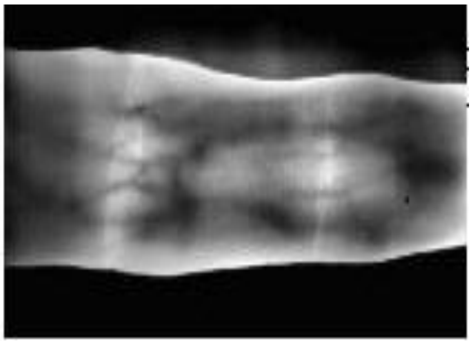

Fig. Enhanced image

Fig represents the contrast enhanced image using contrast limited adaptive histogram equalization.

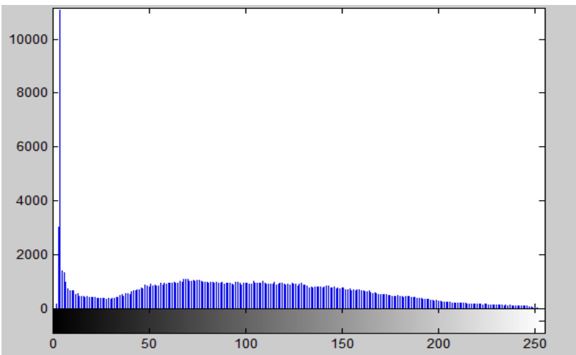

Fig. Histogram plot

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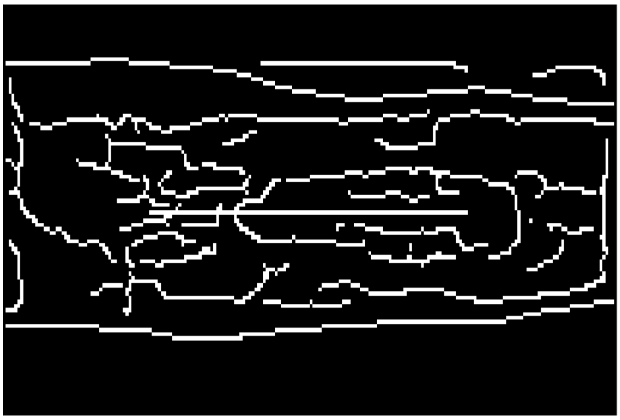

Fig. Skeleton zed image

Fig. represents the skeletonized image . Morphological thinning is applied to the enhanced image to obtain the skeletonized image. Skeletons are computed using iterative thinning. Skeletons images are the basis for chain code comparison.

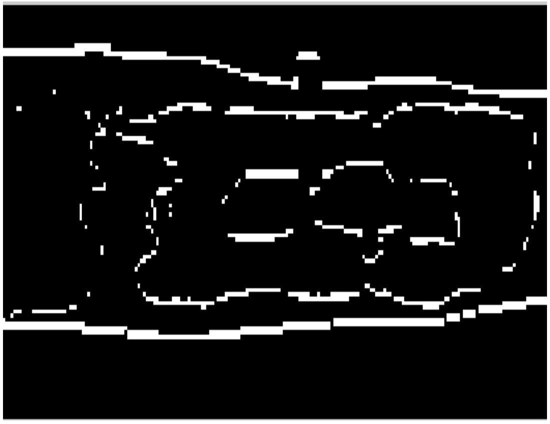

Fig. Thresholding

Then chain code comparison is performed between reference and test skeleton to identify whether the person is authenticated or not.

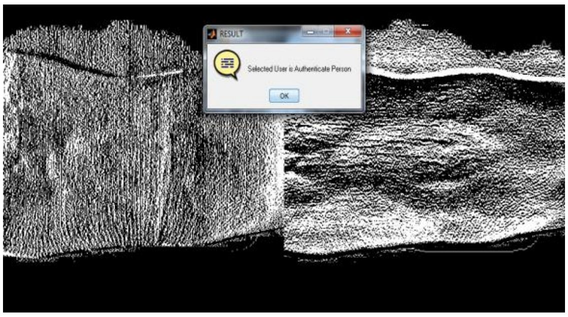

Fig. Authentication

Fig. represents the result of authentication. After chain code comparison, if both reference and test skeletons are matched, then the person is authenticated person, otherwise unauthenticated person.

V. CONCLUSION & FUTURE WORK

In this paper, a multimodal biometric recognition system based on the finger knuckle and finger vein was proposed. An important aspect of the proposed system was the development of FFF optimisation for feature-level fusion. After input images were pre-processed, the FKP was extracted from the knuckle image and vein was extracted from finger vein

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images using the repeated line tracking method. Then, the features were extracted from the finger knuckle and vein by applying the grid operation to the image. Subsequently, the proposed system was fused the obtained feature set with the help of weight score level, which was obtained by feature-level fusion using FFF optimisation method. Then, recognition was performed by the fused feature set using layered k-SVM classifier. The proposed system was evaluated with the existing systems and the performance was analysed by the metrics, FAR, FRR, EER and accuracy. From the outcome, we found that the accuracy was obtained for the proposed method. In future, the proposed method can be extended to develop the different objective functions to find the optimal weight score.

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