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"Developing Secure Tool for the Unique Personal Identification"

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COMPUTER SCIENCE

SUBMITTED BY

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"*Developing Secure Tool for the Unique Personal Identification*"

Abstract

Biometrics trait paying attention from researchers all over the world since the last decade. Improving the accuracy of identification and authentication result uses various approaches had been proposed, like Conventional method, machine-learning method and combination of both. In this synopsis, emphasis mainly on personal Identification using multi feature Biometric System, for this we go through mainly two phases like firstly enrollment phase and second Identification phase. In both phase use some common steps like capturing images, preprocessing, feature extracting, segmentation etc., the aim of enrollment phase is to create trained dataset. In identification phase, identify and recognizing individual person using image template matching technique. To determine the future direction and to fill the research gap in this field by observing existing approaches for identification and authentication.

Keywords: Biometric, Feature Extraction, Preprocessing, authentication, segmentation, Template matching technique.

Introduction

In this advancing era, people want higher security to keep their information and belongings safe. Most of the storing places can be protected with a certain level of security, such as password, pin number etc. using any biometric identification system. The conventional biometric identification system can be categories into two parts. The biometric identification systems that are based on behavioral patterns such as handwriting[1] and keystroke dynamics[2], and the system that are based on physiological patterns such as face and fingerprint. Those systems somehow have several disadvantages[3,4]. The features can be copied fraudulently as they are visible to human eye. Besides that, those biometric features are vulnerable and prone to damage. An example of this type of biometric trait is the fingerprint. Iris recognition is contemplated as least user-friendly biometric. The brightness of the emitting lights during capturing process tends to cause discomfort to human eyes[3]. In addition, the accuracy of face identification is very sensitive towards illumination invariance, facial expressions, poses and occlusions[5]. Table 1 summarizes the characteristics of the previously mentioned methods.

Finger vein recognition is based on images of human finger vein patterns beneath the skin's surface. 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 ATM etc.

3D Finger vein biometric scanner

Since a decade ago, biometric recognition method based on vascular patterns has received much attention among the researchers and technologists. The most popular vascular patterns are hand-vein and finger-vein. A finger-vein biometric system used a specifically designed device to capture image of the vein patterns. The veins are inside of the human's finger. Finger-vein features exhibit several other excellent advantages and these include:

- The finger-vein patterns are unique for every individual, including identical twins. Thus, it offers good dissimilarity between each individual.
- The finger-vein patterns are permanent. It does not change with time.
- The finger-vein patterns are not obscured nor it easily to be replicated or damaged because it is located underneath the human's skin. In another word, it is invisible to human's eyes.
- The finger-vein patterns acquisition is observe from long time that is very user-friendly. The vein pattern images can captured non-invasively. The contactless sensors device ensuring convenience and hygiene for the user.
- Every individual commonly has ten available fingers in very rear case has eleven fingers. Therefore, if something unforeseen incident happens to any one of the fingers, other fingers be used as replacement for authentication[6,7].
- Finger-veins can only be captured from a living body, Hence, if a person is dead, it is impossible to steal his identity[8].

Real-world deployments of finger-vein biometric identification systems the advantages mentioned above, there are challenges that still need to be dealt with in order to achieve the higher performance required. Firstly, the finger-vein image acquisition device has a great impact on the quality of the finger-vein images. During the capturing process, the distance between the finger and camera is very close to one another. This close position could cause optical blurring on the captured image[9]. In addition, the lighting of the capturing device is a very crucial attribute for the system. Poor lighting may cause the image to appear extremely dark or extremely bright[10]. Besides that, the position guidance of the finger is also important. If the finger is not guided, the recognition rate may be decreased, as the finger-images could be misaligned[11]. Thus, mismatch may occur. Other than that, the thickness of bones and skin varied for every individual. Therefore, light scattering may happens, as the human's skin layer is not consistent[7]. The noise on the captured images needs to eliminate as much as possible. Consequently, to overcome those issues, the conventional finger-vein recognition methods implemented complex image preprocessing algorithms to the system[12].

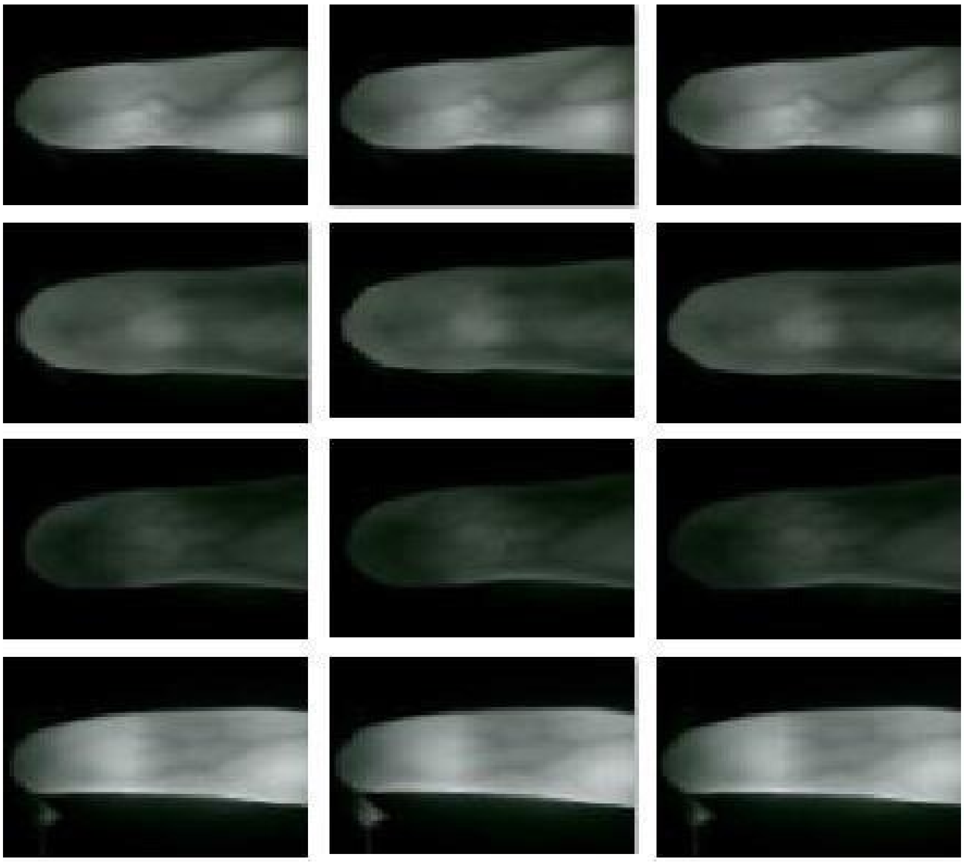

Figure 1 shows various lighting effects in finger-vein samples.

Table 1: Summary of existing biometric traits

Biometric trait	Main Advantage	Disadvantage	Security Level	Sensor	Cost
Voice	Natural and Convenient	Noise	Normal	Non-contact	Low
Face	Remote capture	Lighting conditions	Normal	Non-contact	Low
Finger print	Widely applied	Skin	Good	Contact	Low
Iris	High precision	Glasses	Excellent	Non-contact	High
Finger-vein	High-security level	Few	Excellent	Non-contact	Low

Examples of non-ideal cases are shown in Figure 2.

Finger-vein recognition system can recognized through three approaches. The first approach is by applying a series of image processing modules known as a conventional method. The second approach is by applying machine-learning technique, commonly known as AI method and last approach is Hybrid approach.

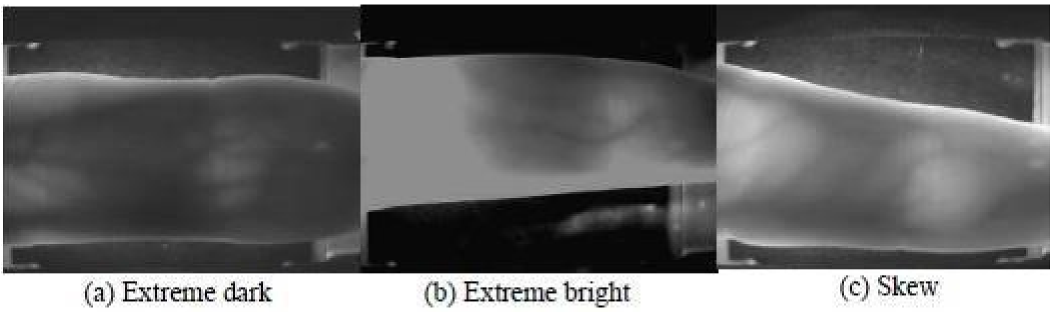

Figure 2. Non-ideal finger-vein samples of SDUMLA-HMT finger-vein database.

Review of Literature

1) **Handwritten signature identification using basic concepts of graph Theory by** TOMISLAV FOTAK, MIROSLAV BAČA, PETRA KORUGA, this paper presents previous work in the field of signature and writer identification to show the historical development of the idea and defines a new promising approach in handwritten signature identification based on some basic concepts of graph theory. This principle can be implemented on both on-line handwritten signature recognition systems and off-line handwritten signature recognition systems. Using graph norm for fast classification (filtration of potential users), followed by comparison of each signature graph concepts value against values stored in database, the system reports 94.25% identification accuracy.
2) **Keystroke Dynamics for User Authentication by** Yu Zhong Yunbin Deng, Anil K. Jain, in this paper they investigate the problem of user authentication using keystroke biometrics. A new distance metric that is effective in dealing with the challenges intrinsic to keystroke dynamics data, i.e., scale variations, feature interactions and redundancies, and outliers. Our keystroke biometrics algorithms based on this new distance metric are evaluated on the CMU keystroke dynamics benchmark dataset and are shown to be superior to algorithms using traditional distance metrics
3) **Evaluate and Determine the Most Appropriate Method to Identify Finger Vein** by Sepehr Damavandinejadmonfareda, Ali Khalili Mobarakehb, Shahrel Azmin Suandic, Bakhtiar Affendi Rosdia,b,c, research paper, the performance of a variety of different methods of dimensionality reduction on finger vein database is evaluated to determine the most appropriate one in terms of finger vein recognition. Principal Component Analysis using K-nearest neighbor (KNN) as a classifier, different types of Kernel Principal Component Analysis (KPCA) using KNN as a classifier, different types of Kernel Entropy Component Analysis (KECA) using KNN as a classifier, and finally different types of KPCA using Local mean-based k-nearest centroid neighbor (LMKNCN) as a classifier are implemented on finger vein database. The accuracy was evaluated using 15,20, 25, 30, 35, and 40 features in each experiment, accuracy rate is from 95.29% to 99.60%.
4) **New Finger Biometric Method Using Near-Infrared Imaging** by Eui Chul Lee, Hyunwoo Jung and Daeyeoul Kim paper proposed a new finger biometric method. Infrared finger images are first captured, and then feature extraction is performed using a modified Gaussian high-pass filter through binarization, local binary pattern

(LBP), and local derivative pattern (LDP) methods. Infrared finger images include the multimodal features of finger veins and finger geometries. The extracted binary patterns of finger images include the multimodal features of veins and finger geometries. Experimental results show that the proposed method has an error rate of 0.13%.

5) **Finger-vein pattern identification using SVM and neural network technique** by Jian-Da Wu, Chiung-Tsiung Liu, in this paper presents a support vector machine (SVM) technique for finger-vein pattern identification in a personal identification system. Finger-vein pattern identification is one of the most secure and convenient techniques for personal identification. In the work, principal component analysis (PCA) and linear discriminant analysis (LDA) are applied to the image pre-processing as dimension reduction and feature extraction. For pattern classification, this system used an SVM and adaptive neuro-fuzzy inference system (ANFIS). The PCA method is used to remove noise residing in the discarded dimensions and retain the main feature by LDA. The features are then used in pattern classification and identification. The accuracy of classification using SVM is 98% and only takes 0.015 s.
6) **Personal identification based on finger-vein features** by Jinfeng Yang , Yihua Shi, Jinli Yang this paper here presents a new method of personal identification based on finger-vein recognition. First, a stable region representing finger-vein network is cropped from the image plane of an imaging sensor. A bank of Gabor filters is then used to exploit the finger-vein characteristics at different orientations and scales. Based on the filtered image, both local and global finger-vein features are extracted to construct a finger-vein code (FVCode). Finally, finger-vein recognition is implemented using the cosine similarity measure classifier, and a fusion scheme in decision level is adopted to improve the reliability of identification. Experimental results is 98.097%.
7) **Research on enhancing human finger vein pattern characteristics** by Xuebing WEN, Jiangwei ZHAO, Xuezhang LIANG research paper, Finger-vein pattern can be applied to personal identification. To enhance the contrast of the finger-vein image that consists of three parts: wavelet denoising, contrast enhancement and binary image, and get the binary image using the OTSU method.
8) **A Survey of Finger Vein Recognition by** Lu Yang, Gongping Yang, Yilong Yin, and Lizhen Zhou, a survey of progress in finger vein recognition is given in this paper. It mainly focuses on three aspects, i.e., the general introduction of finger vein

recognition, a review of the existing research work on image acquisition and feature extraction methods.

9) **Image restoration of skin scattering and optical blurring for finger vein recognition** by Eui Chul Lee, Kang Ryoung Park, proposed a new finger-vein image restoration method to deal with skin scattering and optical blurring. Firstly, the amount of optical blurring of a finger vein image is measured based on the average gradient of the orthogonal profile of a finger edge. Secondly, the accurate point spread function (PSF) of optical blurring is adaptively determined based on the orthogonal profile of a finger edge. Thirdly, a constrained least square (CLS) filter and optimized parameters in terms of the lowest error of finger vein recognition. Experimental results show that the equal error rates (EER) of finger vein recognition with restoration were reduced by as much as 3.14% (5.05–1.91%) compared to the EER without restoration.
10) **Extraction of Finger-Vein Patterns Using Gabor Filter in Finger vein Image Profiles by** Ujwala D.Podgantwar, Prof.U.K.Raut, implement multi-orientation Gabor filters to formulate the framework for the finger-vein feature extraction.
11) **Finger–vein ROI localization and vein ridge enhancement** By Jinfeng Yang , Yihua Shi, in this paper, we first introduces a new and robust approach for finger–vein ROI (region of interest) localization, and then a new scheme for effectively improving the visibility of finger–vein imageries. Extensive experiments are finally conducted to validate the proposed method.
12) **Finger vein recognition with manifold learning** by Zhi Liu, Yilong Yin, Hongjun Wang, Shangling Song, Qingli Li, in this paper, for the first time they address this problem by unifying manifold learning and point manifold distance concept. Based on the infrared image database TED-FV proposed method was obtain the recognition rate 97.8% with identification model and EER 0.8% with verification model.
13) **Comparative competitive coding for personal identification by using finger vein and finger dorsal texture fusion** by Wenming Yang, Xiaola Huang, Fei Zhou, Qingmin Liao, present a multimodal personal identification system that focuses finger vein and finger dorsal images at the feature level. To utilize the intrinsic positional relationship between the finger veins and the finger dorsal, develop a magnitude-preserved competitive code feature extraction method, which is utilized in both the finger vein and finger dorsal images. Furthermore, according to the preserved magnitude, a comparative competitive code (C2Code) is explored for finger vein and

dorsal fusion at the feature level. The proposed feature map of C2Code, which contains new features of junction points and positions from the finger vein and finger dorsal image pairs, is extremely informative for identification. Finally, the C2Code feature map is fed into a nearest neighbor (NN) classifier to carry out personal authentication.

14) **A High Quality Finger Vascular Pattern Dataset Collected Using a Custom Designed Capturing Device** by B.T. Ton, R.N.J. Veldhuis, the number of finger vascular pattern datasets containing 1440 images. This dataset is unique in its kind as the images are of high resolution and have a known pixel density. Furthermore this is the first dataset which contains the age, gender and handedness of the participating volunteers as metadata. The images have been captured using a custom designed capturing device. The various aspects of designing this capturing device are addressed in this paper as well.

15) **An Available Database for the Research of Finger Vein Recognition by** Yu Lu, Shan Juan Xie, Sook Yoon, Zhihui Wang and Dong Sun Park, in this paper, introduce a representative finger vein database captured by a portable device, which is named MMCBNU_6000. Collect finger-Veins image of 100 volunteers, coming from 20 countries. It contains images acquired from different persons with different skin colors. Provide Statistical information of the nationality, age, gender, and blood type is recorded for further analysis on finger vein images.

16) **Human Identification Using Finger Images** by Ajay Kumar, Yingbo Zhou, This paper presents system simultaneously acquires the finger-vein and low-resolution fingerprint images and combines these two evidences using a novel score-level combination strategy. In this paper he developed 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 the proposed system. The rigorous experimental results presented on the database of 6264 images from 156 subjects illustrate significant improvement in the performance, i.e., both from the authentication and recognition experiments.

17) **SDUMLA-HMT: A Multimodal Biometric Database by** Yilong Yin, Lili Liu, and Xiwei Sun, In this paper, the SDUMLA-HMT database used and it consists of face images from 7 view angles, finger vein images of 6 fingers, gait videos from 6 view angles, iris images from an iris sensor, and fingerprint images acquired with 5 different sensors. The database includes real multimodal data from 106 individuals.

18) **Personal Identification For Single Sample Using Finger Vein Location and Direction Coding** by Wenming Yang, Qing Rao, Qingmin Liao, In this paper, propose a structured personal identification approach using finger vein Location and Direction Coding (LDC). Design a finger vein imaging device with near-infrared(NIR) light source, Finally, the structured feature image is utilized to conduct the personal identification on our image database for finger vein, which includes 440 vein images from 220 different fingers. The equal error rate is 0.44%.
19) **Finger Vein Segmentation from Infrared Images Based on a Modified Separable Mumford Shah Model and Local Entropy Thresholding by** Marios Vlachos and Evangelos Dermatas**,** in this paper used Mumford Shah Model. This minimization procedure is computationally intensive for large images, a local application of the Mumford Shah Model in small window neighborhoods, after image enhancement, an accurate segmentation has been obtained readily by a local entropy thresholding method. Finally, the resulted binary image may suffer from some misclassifications and, so, a post-processing step was performed in order to extract a robust finger vein pattern.
20) **Biometric personal identification system based on patterns created by finger veins** by Abrahán Pérez Vega, Carlos M. Travieso, Jesús B. Alonso, in this paper proposed a biometric system to identify people based on the pattern of finger vein. The system uses a database of human index finger images, applied Sobel detector, enhancement filter and a binarization process to get the vein pattern. The testing results have reached an equal error rate of 27.56%, and a Genuine Acceptance Rate of 100% for a False Acceptance Rate of 0%.
21) **Finger-vein pattern identification using principal component analysis and the neural network technique** by Jian-Da Wu, Chiung-Tsiung Liu, in this paper presents a personal identification system using finger-vein patterns with component analysis and neural network technology. The experimental results, the database includes 10 people with 10 samples for each finger. The accuracy of the classification using SVM is 98.00% and only takes 0.015 seconds. Wu and Liu proposed a finger-vein identification using PCA as the feature extraction and neuro-fuzzy inference system (ANFIS) as the classifier in 2011[21]. With 10 people and 10 samples for each finger, the accuracy obtained is 99.00% with 45 seconds response time.

22) **Applying Weighted K-nearest Centroid Neighbor as classifier to Improve the Finger vein Recognition Performance** by Ali Khalili Mobarakeh, Sayedmehran Mirsafaie Rizi, Shadi Mahmoodi Khaniabadi, Mohamad Ali Bagheri, Saba Nazari, In this article proposed a new algorithm for finger vein recognition combining of Kernel principal component Analysis (KPCA) and a new effective classifier called Weighted K-nearest centroid neighbor (WKNCN) which gives 99.7% experimental results.
23) **Computational intelligence-Based biometric Technologies** magazine developed by David Zhang, Wangmeng Zuo, Computational intelligence (CI) technologies are robust, can be successfully applied to complex problems, are efficiently adaptive, and usually have a parallel computational architecture.
24) **Smart access control with finger vein authentication and neural network by** Hoshyar AN, Sulaiman R, Houshyar AN., in this paper demonstrated the feasibility of applying Multilayer Perceptron (MLP) on finger-vein recognition problem. They achieved an accuracy of 93.00% for 7 subjects and 14 test samples.
25) **Finger Vein Recognition Using Lbp Variance With Global Matching** by KUAN-QUAN WANG, ANNE S. KRISA, XIANG-QIAN WU, QIU-Smzhao, presented the identification by applying SVM. Global matching is used to fasten the matching scheme, using extracted features by LBPV. The database includes 10 people with 80 images each. They achieved the accuracy of 96.00% for the ring finger. Souad et al., 201440 achieved 98.75% of 20 subjects and 48 test samples.
26) In 2016, Kalaimathi et al. proposed **a feature extraction method in which a gradientboosted feature algorithm is applied**. Image gradients extract information from input datasets and then a gradient image is calculated from the default image with the use of the Sobel filter. Three parameters are taken into account in order for the algorithm to make a decision: scalability, integrity, and flexibility. After that, classification is performed with the use of a Support Vector Machine (SVM) model.
27) In 2019, Xie and Kumar used **a Siamese CNN model after image preprocessing, enhancement.**
28) **Supervised discrete hashing [28] for finger vein identification**. They compared the results of different configurations of the Light CNN (LCNN) and the VGG-16 models.
29) In 2020, Hu et al. applied a Multi-scale Uniform Local Binary Pattern block to extract local texture features, followed by the application of a (2D)2PCA method based on a block to preserve the local information of the finger vein images.

Objective of the research/ proposed Hypothesis:

Privacy, security, and reliability are one of the most important security issues. The main objective of this research is to introduce a novel Finger-Vein recognition system based on Biometric to manage security issues.

1. Capturing featured images and to create dataset or download dataset from web site.
2. Implement Preprocessing Techniques on the given dataset.
3. Implementing feature extraction techniques, that extracts the multiple unique features
4. Applying, appropriate classification techniques for unique identification.
5. Improve the perfect matching technique for unique identification

Measure the performance of the developed system

Methodology to be adopted:

General biometric system may implemented as per following figure

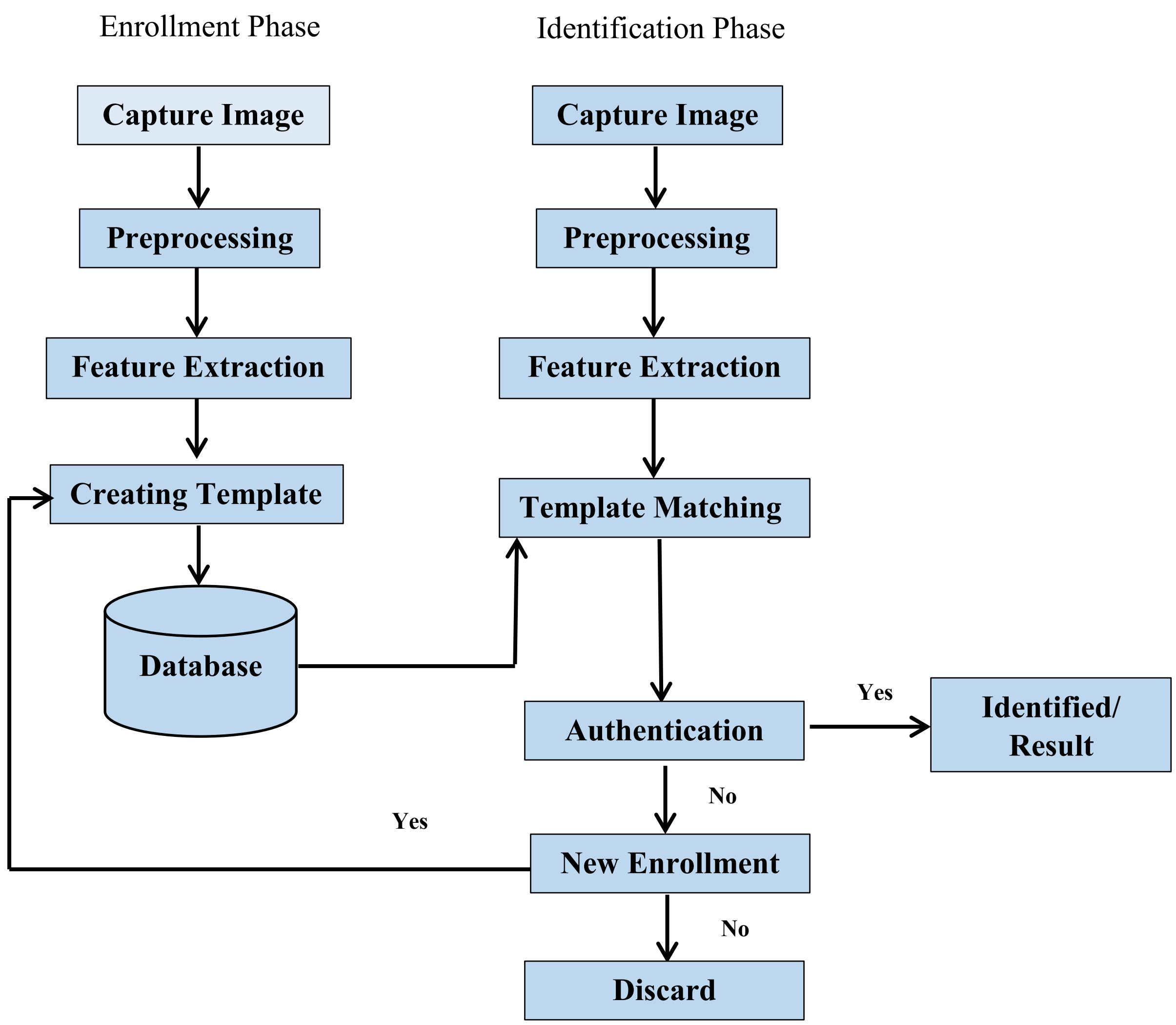

Figure 1 Unique identifaction system using biometric system

The proposed biometric Finger-Vein system uses the finger vein pattern as the biometric trait.

1) Capture Image

Infrared images of the veins can be obtained through the light reflection or transmission methods. In the reflection approach a light source and the camera are placed at the front of the target, while in the transmission case it is located at the back of the target. To obtain the pattern for the database record, an individual inserts a finger into an 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.

According to Modris et al. (2010), the transmission method allows obtaining better results because it shows deep veins, while the reflection systems only shows surface veins. The reflection method can be implemented in smaller spaces, because all the required components can be attached on the camera side. Otherwise, the transmission method needs to have the light source behind the finger, which will increase the total size of the system.

By considering the advantages and the drawbacks of the transmission and reflection approaches, selected the reflection method over the transmission method because of the power consumption and the size of the system.

After acquiring the images they are transferred to a PC to be saved on a database and to be used in further processing. A Image resolution used before selecting the region of interest.

2) Preprocessing

The preprocessing stage prepares the image for the feature extraction phase. This is obtained through several stages: image adjustment, filtering, segmentation, contour detection, key point’s detection and region of interest extraction.

The first step of the preprocessing stage is image adjustment. in order to reduce the computational power required To reduce the size of data. After resizing the raw image, the color space can converted from rgb to grayscale since the luminance information is enough for the image segmentation. The second step of the preprocessing chain is the filtering, used to reduce the noise of the image and to smooth the areas with little variance. This is obtained using a Wiener filter (the same type of filter used by Mauricio Ramalho 2010). The third module performs image segmentation, where the image is segmented into foreground and background through a pre-defined threshold. Thresholding is a very fast way of identifying the finger using the contrast with the black background. After thresholding the image it is converted to binary.

3) Feature extraction

The feature extraction module extract the region of interest and converted on a suitable template. The feature extraction module will output the biometric template, which will be used in the matching stage. The feature extraction technique used in the developed system is the Orthogonal Line Ordinal Features (OLOF) by Sun, et al. 2005 in his work. The vector of luminance values obtained in the preprocessing module will be the input of the OLOF method that will generate a one-bit feature code that is going to be the template stored in the database.

4) Template Matching

In this module, the system checks the database for similar templates. The matching is processed by computing a similarity score between the new and the stored templates. A successful or unsuccessful recognition of an individual is based on the calculation of the bitwise Hamming distances of the recently acquired template and all the others in the database.

Proposed Work Plan / Formulation and structure of study: (Year-wise Plan of work and targets to be achieved):

- Review and data analysis (9 months)
- Training of data sets (next 3 months)
- Research papers in Journal and conference (tentatively 13 to 24 months)
- Book chapters / Articles (tentatively After 24 Month)

Importance of study / society application:

Companies, Government Institutions, Educational & Research Institutions across the world are investing time and money in Biometric technology in order to make their environment safer and more reliable and for Personal identity and authentication.

According to S. Crisan, et al. vein authentication is not only interested in lab researchers but also in industries, and the products perform well in tests of the **International Biometric Group** (IBG).

According to International Biometrics Group (IBG) research report, the global market for Biometrics slated for high growth through 2014.

Key Forecasts:-

1) The total biometrics market will grow at a 22.3% CAGR for the next five years, thus reaching $9.37 billion in 2014 in industry revenue.
2) International Biometric Group Expects Biometric Market to Nearly Triple by 2014
3) Vein recognition has expected to play a larger role in access control applications, eventually comprising more than 10% of this market.

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