Assessment on Extraction and Matching of Finger Vein and Iris Pattern based Authentication System

K. Appasamy, R. S. Shanmugasundaram

Abstract: ***Biometrics uses human behavioral features for personal identification and has become most popular and promising alternatives than the traditional methods. The vein pattern is hidden inside the body and hence the problem of forgery in vein is consequently reduced when compared to fingerprint. Iris is one of the most reliable biometric traits due to its uniqueness and stability. The uniqueness of iris texture comes from the random and complex structures such as furrows, ridges, crypts, rings, corona, and freckles etc. which are formed during gestation. Often iris is combined with other biometric features for robust biometric systems. The finger vein pattern acquired under infrared light is used to design an accurate personal authentication system. The personal identification method based on vein extract the patterns from an unclear original image and line tracking operations with randomly varied start points are repeatedly carried out. This paper reviews various techniques introduced in finger vein and iris recognition system. This paper mainly focuses in introduction about finger vein and iris pattern, survey of existing research works done in the process under finger vein combined with iris recognition such as image acquisition, vein and iris enhancement, vein and iris pattern extraction and vein and iris pattern matching. Finally the challenges and future work are discussed in order to improve the left finger vein pattern with right iris and right finger vein pattern with left iris recognition.***

Keywords: ***Finger Vein Pattern, Finger Vein Recognition, Image Acquisition, Iris Classification, Iris Image Acquisition, Iris Image Segmentation, Iris Recognition, Iris Texture Analysis, Pattern Extraction, Vein Enhancement, Vein Pattern Matching.***

I. INTRODUCTION

In particular, a biometric system is a pattern recognition system which acquires a person's biometric data, extracts a feature set from the data acquired, and compares the feature based on the application context a biometric system can work either in the authentication mode or in the identification mode. The computer validates the identity of a person in the validation mode by comparing the captured biometric data to its own biometric model stored in the system database.

The system recognizes a person in the recognition mode by looking for a match for the models of all users in the database. Intrinsic psychological patterns are difficult to observe and therefore offer a high degree of security. Vein structures are subcutaneous and hidden and hence cannot be seen by naked eye. It has higher security and reliability compared to the traditional authentication systems that are used in today's technology such as password or code as biometric features are difficult to forge. The security system can be categorized into two main types which are known as traditional methods and biometrics methods. The traditional security methods such as key, smart card, passwords and Personal Identification Number (PIN) are easy to be forgotten and stolen. These traditional methods of identification are now being replaced by the methods of biometry.

The physiological traits include fingerprint, face, iris, etc. Several types of biometric techniques based on these anatomical / behavioral characteristics have been developed, including fingerprinting, palm printing, hand veins, finger veins, palm veins, foot vein, iris, gait, Recognition of DNA, palates, recognition of speech, expression of the eyes, breathing, signature, language of the body and shape of the head. Extrinsic features are more visible and have more adverse factors when compared to the intrinsic features. For example, the retinal layer is affected by the high intensity of light during iris extraction. Similarly, due to brightness variance, facial style, blockage of blood vein and pose, the accuracy of facial identification is also distorted.

Finger vein recognition algorithm based on gradient-correlation is presented Lin Chunyi, sLi Mingzhong, Sun Xiao [1]. First, a method based on histogram statistics is used to recognize whether or not finger vein images. Second, a matched filter based on the maximum curvature model is used to extract the finger vein gradient image. Eventually, to approximate their similarity, the cross-correlation between two gradient objects is calculated.

Recognition of finger veins is one of biometric authentication methods for identification of individuals and identity verification. It uses techniques for pattern recognition based on images of human finger vein patterns. Such vein patterns are distinct even among the twins.

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* Correspondence Author
K. Appasamy*, Research Scholar, Department of Computer Science, Vinayaka Mission's Research Foundation (Deemed to be University), VMKV Arts and Science College, Salem, Tamilnadu, India. Email: appas_k@yahoo.co.in
Prof. Dr. R. S. Shanmugasundaram, Deputy Director cum Nodal Officer, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamilnadu, India.

The vein-based authentication system incorporates biometric pattern models for security and convenience for personal identification. Fig.1 authentication system based on finger vein and iris block diagrams. First the different person’s finger veins and iris patterns are collected and stored in a database and then feature values are trained. Then the input image is pre-processed and enhanced to get better output.

Then extracted vein and iris pattern image is matched with a database image. If they matched then the person will be authenticated otherwise it is considered as unauthenticated.

The typical framework of the authentication system based on the biometric finger vein and iris is presented in

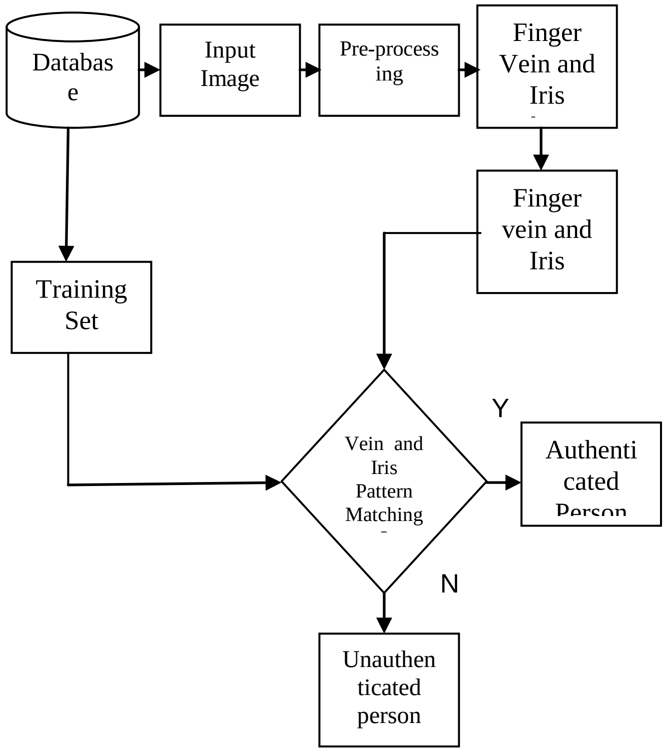


Figure 1. Typical framework for finger vein and iris based authentication system

A. Types of Biometrics

The two main characteristics of biometric identifiers depend on either physiological characteristics or behavioral characteristics.Physiological markers contribute to the user's identification structure, including facial recognition, fingerprints, finger morphology (finger length and position), iris recognition, vein recognition, retina/ scanning, voice recognition and DNA matching. Behavioral identifiers include the unique ways in which individuals act, including recognition of typing patterns, way of walking and other gestures.

B. About Finger Vein and Iris

Veins are blood vessels which present throughout the body as tubes that carry blood back to the heart. The finger vein, as its name suggests, is the small blood vessels inside the fingertips. The iris of eye is unique to each individual. Because the iris is an internal part of the body, it is very safe and hard to forge. Iris recognition systems are non-invasive in nature for practical applications it is a very important aspect. Image processing techniques are one of the most common and effective methods used for such research. Image processing can be used for formulation of an iris pattern to unique code which can be stored in a database and used for comparison purposes.

C. Finger Vein Recognition

Finger vein recognition is a biometric authentication method that uses pattern recognition techniques based on pictures of human vein patterns below the skin surface. Most forms of biometrics used Finger vein patterns are relatively hard to fake as they are located below the skin surface.

D. Finger Vein and Iris Pattern

It is a process wherein a person's finger vein patterns are used as a basis for biometric authentication. Images are taken of one's finger vein patterns and then verified through pattern recognition techniques. The veins of each individual have unique physical and behavioral features. It provides a greater degree of security that provides much better protection of information and access control. Because deoxyhemoglobin absorbs infrared lights in the blood, vein patterns appear as several dark outlines.

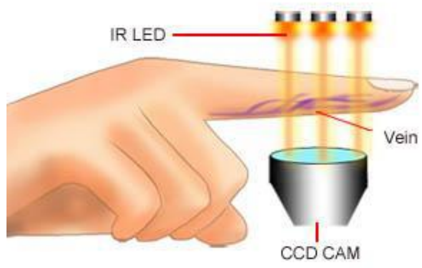


Figure 2. Sample Image for Finger Vein Recognition –Courtesy (comparison of various biometric methods, rupinder saini , narinder rana)

Figure 2 shows the combination of infrared lights with a special camera capturing an image of the finger vein pattern. This image is then converted into pattern information together with the biometric authentication model save. While authentication, the particular image of the finger vein is taken and compared with the person's saved template. Also known as vein matching or vascular engineering, finger vein identification.

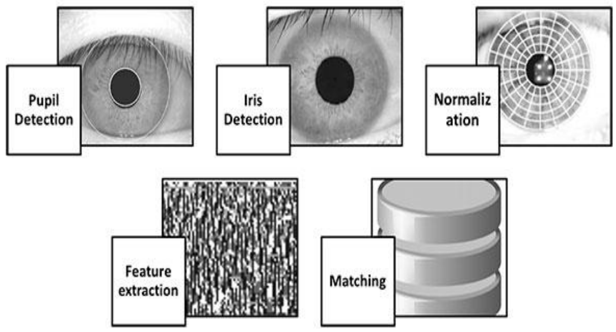


Figure 3. The various steps involved in iris recognition Iris-recognition-scanners-vs-fingerprint-scanners

Fig 3 explains about pupil detection. Here the pupil needs to be detected and removed from the acquired eye image since only the iris pattern is used for matching purpose. Using Iris detection the outer iris boundary is detected by using intensity variation approach. Concentric circles having different radii are drawn from the detected center.

In this approach, the iris circle is detected by locating the circle that shows the highest change in intensity compared to the previously drawn circles.

In Normalization the localized iris image is converted into strip. The Cartesian coordinates are first transformed into its polar equivalent after which the mapping is done

The transformed iris image is composed of points which are taken from the pupil boundary to the outer iris boundary. This essentially means that the same group of points is considered for every image. The iris image needs to be normalized to ensure that the size of strip remains constant for different images. The size of same iris image however might vary due to the expansion and dilation of pupil. So the size of iris strip is constant for every iris image.

In Feature extraction the unique characteristics of the iris are derived by extracting the attributes or values of the image. These attributes or values are known as features and are extracted from the iris image using Haar Wavelet decomposition process. The Haar Wavelet process decomposes the image into four coefficients – horizontal, diagonal, vertical and approximation.

Using Matching process the hamming distance approach is used to compare the iris codes (IC) that are generated for the database and query images. The difference between the bits of two codes is counted in this approach and the number is divided by the total number of comparisons. This matching score is provided as input to the fusion module that generates the final matching score.

E. Capturing Finger Vein Data

Fig 4 explains about finger vein images which are captured in dissemination pattern Data present primarily in vein position and distribution.Terminal points, bifurcation points and turning points provide the greatest quantity of data and are therefore used as data featured.

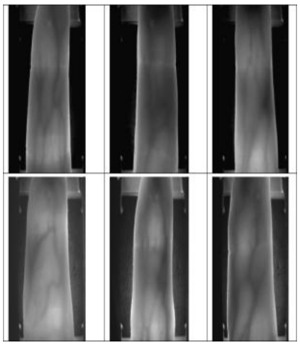
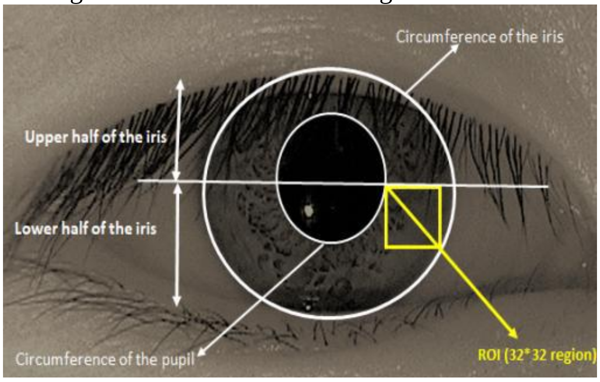


Figure:4. Finger Vein images – Courtesy [Finger Vein Recognition Based on a Personalized Best Bit Map Gongping Yang, Xiaoming Xi, and Yilong Yin]

II. FINGER VEIN AND IRIS FEATURES EXTRACTION AND MATCHING

In Fig.5 Certain enhancement is required to get the precise features during the feature extraction. Contrast enhancement of the Region of Interest is carried out using image histogram equalization. Gaussian filtering is applied to remove the noise as well to retain the edge details.

Unique mark and finger vein highlights coordinating is the way toward coordinating the present finger vein with the pre-spared finger vein formats, and to decide if two finger vein pictures are caught from a similar finger. There are two noteworthy kinds of coordinating finger vein: Finger Vein Verification and Finger Vein Identification.



Firgure 5. Iris region if interest for feature extraction-Courtesy

[Feature Level Fusion of Iris and Finger Vein Biometrics for Multimodal Biometric Authentication System, Sudhamani M J, M K Venkatesha]

Finger Vein Identification (1:1) implies the storage in a certain effective format of personal information and finger vein features of a person in a database and the collection of finger vein image information for 1:1 to match the features stored and determine whether there are two features of the same finger. Meanwhile, finger veins can be matched in different ways, including fingerprints, finger veins and fingerprints and veins.

To process finger vein acknowledgment, no other data of the client is required. Finger vein picture information caught nearby will be contrasted and a few spared information one by one, and attempt to coordinate inside those information. This is a "1:N" correlation.

The localization of the iris needs to be carried out using edge detector. Among many edge detectors available in the literature, canny edge detector is suitable to find the edges. Edge detection is followed by finding the circular structure utilizing circular Hough transform.

III. TYPICAL FINGER VEIN AND IRIS IDENTIFICATION SYSTEM

Personal identification based on finger vein patterns proposed by Naoto Miura, Akio Nagasaka, Takafumi Miyatake[2]. This method image of a finger captured under infrared light contains not only the pattern of the vein but also the irregular shading produced by the different bone and finger muscle thicknesses. Yang L suggested using the width of the phalangeal joint as a soft biometric feature to enhance the accuracy of finger vein recognition, using Gabor to extract finger vein patterns, and fuse the vein and finger texture [3].

In Figure 6. Hashimoto proposed that there are two ways of finger vein image acquisition, i.e., light reflection method and light transmission method. The main difference between these two methods is the position of near-infrared light. In the light reflection method, near-infrared light is placed in the palmar side of the finger and the pattern of the vein of the finger is captured by the reflected light from the palmar surface of the finger.

Compared with light reflection method, light transmission method can capture high-contrast image, so most of image acquisition devices employ light transmission method [4].

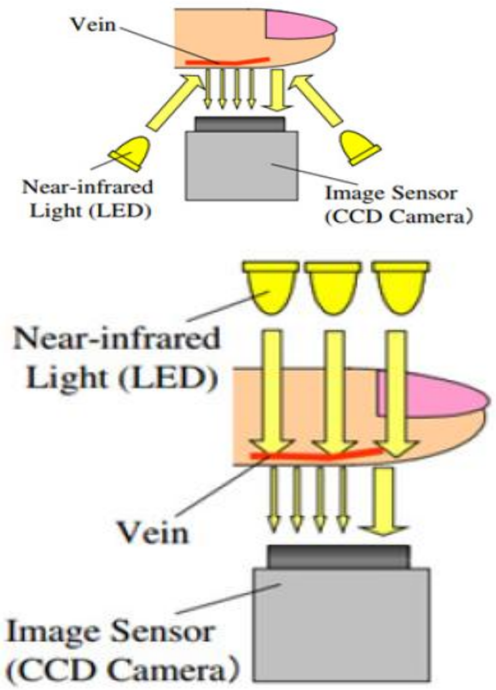


Figure.6 Two ways of finger vein image acquisition

(a). Light reflection; (b). Light transmission- Courtesy [Finger Vein Authentication Technology and its Future, Junichi Hashimoto]

Gaussian high pass filter by binarization method was proposed by Lee, E.C., Jung, H., Kim, D First, infrared finger images are captured and then extracted using binarization, Local Binary Pattern (LBP) and Local Derivative Pattern (LDP) methods using a modified Gaussian high pass filter[5].Infrared finger pictures include finger vein and finger structure multimodal features. The proposed method showed promising recognition performance without any finger alignment algorithm by using adequate finger image capturing scheme.

Lu, Y., Xie, S.J., Yoon, proposed the Region of Interest method of finger vein position with high efficiency and robustness compared to the factors mentioned above. The proposed method consists of a set of steps to accurately locate the region of interest, namely segmentation, correction of orientation and identification of region of interest. Frangi filter was used to extract the finger vein structure from finger vein images. Two extended edge operators are used first for the segmentation of the coarse finger region. This was verified to result in a faster speed than those using the masks. For the images in the abnormal case, elaborate binarization is proposed to remove the false background caused by the influences from uneven illumination, scattering, and improperly collection. Removing false backgrounds and estimated corrected orientation angle can be guidelines for getting a more accurate finger region for each other. Finally, an extended ROI detection method is used based on searching the reference line in the finger's second knuckle. To alleviate the influences from the uneven illumination and variation of finger width, the reference line is derived from the vertical projection of block image truncated from the segmented or orientation corrected image [6], [7].

Shrinivas Rao B et al. proposed a method which extracts the iris data by separating the iris region from the pupil and sclera, using roipoly and inverse roipoly [8]. Using a reduced pixel block algorithm, the extracted features suit the stored repository.

Serestina Viriri and Jules Tapamo implemented two majority vote-based strategies for the creation of a single iris template per user [9]. A cumulative-sum gray change analysis algorithm is used to extract the iris texture characteristics for the development of templates.

Umesh, Harkesh Sehrawat [10] explained the finger vein pictures are upgraded by consolidating the idea of nearby histogram balance, which enhances the neighborhood difference of a picture. The Region of Interest of finger images was successfully extracted by applying morphological operations irrespective of any illumination variations and these images were enhanced using local histogram equalization. This was done to enhance small object areas in the image locally that is not possible by applying global histogram equalization method.

Naoto Miura, Akio Nagasaka, Takafumi Miyatake described a personal identification method based on patterns of veins in a finger. Original photo, line-tracking operations are conducted repeatedly with arbitrarily varying starting points. Evaluation of its robustness against image darkness showed that it is far superior to the conventional method based on a matched filter [11].

Naoto Miura developed the calculation of maximum local curvatures in cross-sectional profiles of a vein image [12]. This technique will accurately predict the centerlines of the veins without the differences in vein size and strength being affected, making it highly accurate to fit the pattern.

Ajay Kumar, Yingbo Zhou [13] implemented simultaneously acquires finger vein and low-resolution fingerprint images and combines these two proof using a new score level The utility of low-resolution fingerprint images acquired from a webcam is examined to evaluate the corresponding quality. The author introduces and examines two new combinations of score scales, i.e. holistic and nonlinear fusion, and compared compares them with more traditional approaches to fusion level score in order to determine their efficacy in the proposed system.

Wonseok Song, Taejeong Kim et al proposed a new finger-vein extraction method using the mean curvature [14]. This method uses geometrical properties of the intensity field, which makes it possible to extract the pattern of undefined veins from the photos. By running the region's growing operator on the various seeds, Huafeng Qin Lan Qin Chengbo Yu developed a novel vein pattern extraction approach [15]. Segmentation method called threshold image for rough segmentation and obtaining binary and skeleton image of the finger vein and further specified fingervein width is determined on the basis of the binary and skeleton image described by Liu, T., Xie, J.B., Yan, W., Li, P.Q., Lu, H.Z. [16] The updated repeated line tracking algorithm is then performed on the basis of the revised parameters to be used to determine the locus space of the finger-vein.

IV. FEATURE EXTRACTION

Zhi Liu et al proposed the problem by unifying the concept of multiple learning and point manifold distance [17]. TED-FV-based experiments show that the proposed algorithmic framework is robust and effective.

Xuzhou Li1,2 , Xiaoming X et al. [18] proposed a method of finger vein identification, extracting binary patterns such as Local Binary Pattern based on the finger vein picture without vein segmentation. The extracted feature may contain some noise due to the low quality of the finger vein image. This proposed Personalized Discriminative Bit Map based on LBP, and selects the stable bits for final matching from the binary bits, this method can degrade the noise to some degree and achieve better performance.

Debnath Bhattacharyya, Poulami Das [19] et al proposed a new biometric-based Iris feature extraction system. By using a series of correctly positioned sensors, the system automatically acquires the biometric data in numerical format (Iris Images). The proposed considered camera as a high quality sensor. Iris Images are typically color images that are processed to gray scale images. Then the Feature extraction algorithm is used to detect "IRIS Effective Region (IER)" and then extract features from "IRIS Effective Region (IER)" that are numerical characterization of the underlying biometrics.

V. CLASSIFICATION

Yang, G.P., Xi, X.M., Yin, Y.L proposes that the Principal Component Analysis be extended to the extraction of finger vein characteristics on the basis of which a new method of recognition is introduced in combination with metric learning [20].

S. Khella-Kihel et al. [21] has introduced Multimodal fusion of finger-knuckle print, finger print and finger's venous network by adopting several techniques is used for different levels of multimodal fusion. For feature selection Kernel Fisher Analysis algorithm is used. Support Vector Machines and K-Nearest Neighbor is used for classification.

Based on the spatial distribution of the training objects and their distance from the test object, Bakhtiar Affendi Rosdietal the proposed FkNCN uses a surrounding rule to obtain neighbors k-nearest centroid [22].

Vinothkumar, R. Sanmugasundaram, D. Divya, S. Padma Sarath [23] proposed Finger Veins are the non imitable biometric Identification. The proposed system uses Finger vein Recognition system using Near Infra Red laser, Non-contact finger vein acquisition system using Near Infra Red laser, Extraction of Finger vein patterns using repeated line tracking method, Finger vein evaluation using Support Vector Machines, Extraction of vein patterns of fingers based on curvelets and neural network layout of local interconnection.

Lovelesh Khard, Raju Baraskar, Uday Chaurasia proposed survey is done on fingerprint recognition techniques and different approaches are studied in terms of accuracy and performance [24]. As fingerprint may also contain noise; so image de-noising techniques are also studied Cross ridge frequency analysis of fingerprint images is performed by means of statistical measures and weighted mean phase is calculated. These different features along with ridge reliability or ridge centre frequency are given as inputs to a fuzzy c-means classifier.

Kakde Sachin,V.Anandam, et al discuss about the elaborated study of various gift implementation define strategies together with their comparative measures and result analysis thus as realize a brand new constructive technique for finger print recognition [25].

T.M.Sirisha, R.Bala Dinakar discussed different filtering techniques and also coded which technique is useful for efficient removal of specific noise such as Mean filter is for smoothing images, Geometric Mean for removal of Gaussian noise, Harmonic &Contra harmonic for removing positive outliers and Max and Min filter for salt and pepper noise etc., These mentioned methods conclude that the fingerprint is fast and accurate for more reliable and secure system [26].

Uday A.R, G.Sreelakshmi, [27] implemented a novel matching scheme to detect the matched minutiae of pairs incrementally. The iris characteristics are captured effectively using the edge detection algorithm. As a result, the maximum score is calculated by cross correlation and used as the parameters of recognition. This way of combination has provided efficient recognition results which had overcome the existing drawbacks.

Wencheng Yang, Song Wang et al Proposed finger-vein-based bio-cryptosystem that not only authenticates, but can also encrypt sensitive health care data using the biometric cryptographic technique of the Fuzzy Engagement System (FCS). The experimental results and the study of protection indicate the validity of the proposed scheme [28].

Shaila. S.G, V. Suma Avani Rashmi explained about framework gets the finger-vein and finger-texture images at a time [29]. Camera is used to obtain the finger vein and finger texture images. The utility of low-determination finger vein and finger texture images is analyzed to learn the coordinating execution. The low determination images are improved by joining the upgrade strategy Contrast Limited Adaptive Histogram Equalization (CLAHE) and middle filter. The division of Region of Interest (ROI) at various determination levels and the pivot interpretations makes the framework profoundly proficient.

Wenhao You &, Weikang Zhou &, Jing Huang is proposing a new approach for solving finger vein imaging skin scattering problems. Firstly, a new diffusion Point Spread Function (diffusion-PSF) model is proposed to accurately describe light scattering in finger tissues Secondly, the blur-SURE method (Stein's objective hazard estimate) is used to accurately estimate the parameters of the diffusion-PSF system. Ultimately, the multi-Wiener SURELET approach (Linear expansion thresholds) is used to boost the parameters [30].

Wenjie Liu, Weijun Li, et al. proposed seven layers of Convolution Neural Network which include five convolution layers and two fully-connected layers [31]. This network obtains a recognition rate of 99.53%, which proves to be better performing than traditional algorithm.

Kun Su, Gongping Yang, Lu Yang, Yilong Yin proposed a finger vein image retrieval scheme based on Affinity-Preserving K-means Hashing (APKMH) algorithm and bag of subspaces based image feature.

This paper explains about finger vein image by Nonlinearly Subspace Coding (NSC) method which can obtain the discriminative finger vein image features. Then the features space is partitioned into multiple sub segments [32].

Haiying Liu, Lu Yang, et al proposed new local discriminative feature learning method for finger vein recognition [33]. Unlike most previous finger vein recognition methods, which use hand-crafted descriptors such as local binary pattern, local line binary pattern, and Gabor features, but this paper aims a function mapping to improve local characteristics discriminative ability In order to achieve this goal, this paper derives multidirectional pixel difference vectors (MDPDVs) for each pixel in a training finger vein image by measuring the difference between each second pixel, explores a feature mapping to project these MDPDVs in low-dimensional binary codes in a supervised manner, where: 1) the loss between the original real-value codes and the learning experience. binary vectors are minimized 2) the variation of local binary characteristics between classes is maximized and 3) the variation of local binary characteristics within class is minimized..Finally represents about the clustering and pooling of these binary codes characterizes each finger vein picture as a histogram.

Xinwei Qiu, Wenxiong Kang, et al [34] suggested that both blurriness and noise distribution are slightly different between real and forged finger vein images, and that robust methods be used to detect presentation attacks using forged finger vein images (print artifacts). First, Total Variation Control (TV) was defined to decompose native finger vein images into structure and noise composition reflecting the degrees of blurriness and the distribution of noise. Next, a local binary pattern (LBP) block descriptor is used in the decomposed components to encode both structure and noise information. Basically, a cascaded support vector machine (SVM) classification system is used to detect finger vein presentation attacks effectively.

Priya M.RavaleNerkar, the biometric authentication built, is gaining popularity as it provides high security and reliable personal authentication approach [35]. Vein biometrics is one of the emerging techniques compared to other biometric systems due to its strengths of low risk of forgery, detection of vitality and stability. A survey on different techniques used for different processes for authentication is described in this paper. Finger vein has an outstanding promise in various applications. The vein quality factor is the Equal Error Rate (EER) measured using different algorithms.

P.Gopinath, R.Shivakumar, explained about Finger vein biometric pattern is an emerging technique for personal identification and authentication for having more security and convenience. Finger vein among researchers has gained much attention to combine accuracy. This study makes on review over various approaches for finger vein feature extraction. The finger vein basic principle, feature extraction, evaluation procedures are analyzed extensively and systematically. The three part finger vein image acquisition, pre-processing and feature extraction are described specifically in various existing techniques [36].

Vanaja Roselin. E.Chirchi,Laxman. M. Waghmare, explained about enhancing iris recognition algorithm based on Haar wavelet with quality texture features of iris within feature vector, even though obstruction of eyelashes and eyelids and also works perfect for narrowed eyelid as it consider small part of the iris even though it is occluded [37]

Aalaa Albadarneh Israa Albadarneh, presents an iris recognition system for user authentication [38]. To design the proposed iris authentication system reviewed and evaluated four iris pattern recognition features including Histogram of Oriented Gradients (HOG), a combination of Gabor and Discrete Cosine Transform (DCT) and Grey Level Co-occurrence Matrix (GLCM).

Akram Gholami, Hamid Hassanpour proposed the veins are extracted from finger vein images by using entropy based thresholding. In finger vein images the veins are appeared as dark lines. The method extracts veins as well, but the images are noisy, that means in addition to the veins they have some short and long lines. Then radon transformation is applied to segmented images. The Radon transform is not sensitive to the noise in the images due to its integral nature, so in comparison with other methods is more resistant to noise. For extracting dominant features from finger vein images, common spatial patterns (CSP) are applied to the blocks of radon transformation. Finally the data classified by using nearest neighbor (1-NN) and multilayer perceptron (MLP) neural network [39].

Yu Lu, Sook Yoon and Dong Sun Park described about three-dimensional (3D) structure of finger veins located inside a finger, a novel finger vein identification system (FVIS) using two cameras with different fusion technique [40]. Compared to the traditional single-camera FVIS, the proposed system will produce more biased data by fusing information from two simultaneously recorded images and improving the corresponding accuracy.

S. Veluchamy L.R. Karlmarx proposed a multimodal biometric system by using fractional firefly (FFF) optimization to combine the finger knuckle and finger vein images at feature-level fusion.. Initially, the characteristics are extracted from the photographs of the finger knuckle and finger vein using repeated line tracking method. This newly developed method of feature-level fusion using FFF optimization is used. The recognition is carried out by the fused feature set using layered k-SVM (k-support vector machine) which is newly developed by combining the layered SVM classifier and k-neural network classifier. The experimental results are evaluated and the performance is analyzed with false acceptance ratio, false rejection ratio and accuracy [41].

Rupinder Sain, Narinder Rana [42] suggested comparing various biometric systems simply by identifying their advantages and disadvantages. A brief introduction is usually offered to commonly used biometrics, including Face, Iris, Fingerprint, Finger Vein, Lips, Voice. The list of comparison criteria introduced is limited to accuracy, size of the template, cost, safety level and long-term stabilization.

T.Sheeba, Ruwi, Sultanate of Oman M.Justin Bernard discussed about a survey of multimodal fingerprint and finger vein recognition techniques [43]. Most of the existing work is systematically described and compared in five chapters, i.e., the acquisition of fingerprints and finger-vein images, pre-processing, extraction of features, matching and fusion.

Fingerprint and finger-vein multimodality ensures higher performance and spoofing resistance based on the work available in literature and commercial use experiences. This multimodal technology has reached a level of security, accuracy and efficiency unparalleled.

Feifei CUI, Gongping Yang, proposed multimodal biometric recognition based on score-level fusion of fingerprint and finger vein, as fingerprint recognition and finger vein recognition are complementary in several respects [44]. Experimental results based on homologous biometrics show that fusion of fingerprints and finger veins leads to significant improvements in performance.

P. M. Gomathi, G. M. Nasira [45] proposed the conventional method for user authentication is a password known to the user only. There is no security when using passwords if an imposter knows the password and it can also be forgotten. Therefore, a better security system needs to be developed. Hence, to improve the user authentication passwords are replaced with biometric identification of the user. So a better classifier is necessary to perform this task. Some of the commonly used classifier is focused on fuzzy logic, neural network, etc. Neural network can also be effective in classification. This survey provides different biometric-based authentication system based on neural network.

Zhi Liu and Shangling Song [46] have proposed a real-time finger-vein recognition system for mobile device authentication. The system is built on a Digital Signal Processor platform and is fitted with a new finger-vein recognition algorithm. The proposed system only takes about 0.8 seconds to validate one input finger vein sample and achieves an equivalent error of 0.07 percent.

Liukui Chen,Jing Wan [47] presented the design of a personal identification system based on near infrared (NIR) finger vein image In this paper, the researcher presented a finger vein imaging observation system on which a self-adaptive illuminance control algorithm is proposed and incorporated into the image acquisition hardware. Gabor filters are used in the pre-processing cycle to improve recorded raw finger.

Haiying liu,lu yang,et al. proposed a new local discriminative feature learning method for finger vein recognition. Unlike most previous finger vein recognition methods, which use hand-crafted descriptors such as local binary pattern, local line binary pattern, and Gabor features, this paper aims to learn a feature mapping to enhance the discriminative ability of local features [48].

Ajay Kumar, Yingbo Zhou [49] has implemented a new method to improve the performance of the literature's finger vein recognition systems. At the same time, the proposed system acquires finger vein and low resolution fingerprint images and uses a new combination score level technique to incorporate these two facts.

Yu Lu, Sook Yoon et al explained Finger vein images contain rich oriented features. Local line binary pattern (LLBP) is a method represents an extended local binary pattern (LBP), but is limited in that it can only be extracted horizontally and vertical line patterns, so effective information in an image may not be exploited and fully utilized [50]. In this paper, an orientation-selectable LLBP method is proposed for finger vein recognition, called generalized local line binary pattern (GLLBP). GLLBP extends LLBP to any orientation for extraction of line patterns. The soft power metric is used to measure the matching score in order to effectively increase the matching accuracy.

Fotios Tagkalakis ,Dimitrios Vlachakis, proposed [51] efficient detection of the non-vein regions, in order to define the main vein patterns. The proposed method is effective in capturing and illustrating not only the pattern of the vein of the finger, but also other essential features such as the width of the veins. The false acceptance and false rejection rates achieved are 0% and 0.5% respectively.

Gongping Yang, Rongyang Xiao, et al discussed a method of finger vein recognition based on personalized weight maps (PWMs), consisting primarily of pre-processing, extraction and matching. Finally, extensive experiments were designed to evaluate the efficacy [52].

Fei Liu, Yilong Yin, et al present a novel recognition system that uses finger vein super-pixel-based features (SPFs) for high-level representation of features [53].

Xiaoming Xia, b, Lu Yanga, b, Yilong Yinc, author says a novel binary discriminative code (DBC) method of learning is proposed for the identification of finger veins [54]. First, to capture comparisons between subjects, the graph of the subject relationship is built. The binary templates are transformed based on the relationship graph to describe the vein characteristics of the subject.

N. Angayarkanni suggested a finger vein imaging observation system using a self-adaptive bilateral illuminance control algorithm based on a filter [55]. The algorithm could adjust the lighting distribution automatically. Based on its thickness distribution, the whole finger body could be adequately illuminated and overexposure and underexposure were effectively prevented.

Di Huang, Yinhang Tang, et al proposed a novel approach to hand-dorsa vein recognition through matching local features of multiple sources [56]. In contrast to current studies only concentrating on the hand vein network, but this system also make use of person dependent optical characteristics of the skin and subcutaneous tissue revealed by Near Infra Red hand-dorsa images and encode geometrical attributes of their landscapes. Specifically, the proposed method adopts an effective key point detection strategy to localize features on dorsal hand images, where the specialty of absorption and scattering of the entire dorsal hand is modeled as a combination of multiple (first, second, and third) order gradients.

Bogdan belean, mihaela streza, et al introduced a novel approach to user authentication based on analysis of the dorsal hand vein pattern and classification of the neural network multi-layer perceptron.. For image processing two different techniques are employed rotation invariant Hough transform and clustering based segmentation and mathematic morphology [57].

Jinfeng Yang, Ben Zhang and Yihua Shi [58] proposed first give an analysis of the intrinsic factors causing finger-vein image degradation, and then propose a simple but effective image restoration method based on scattering removal. To give a proper description of finger-vein image degradation, a biological optical model (BOM) specific to finger-vein imaging is proposed according to the principle of light propagation in biological tissues.

WenmingYang, Yichao Li, et al developed a weighted Spatial Feature Interdependence Matrix [SFIM] based on probability and direction (PDSFIM). The SFIM combines both the likelihood and position of the vein lines in a patch. After comparison with various state-of - the-art methods the experimental results show the superiority of the proposed method [59].

Hyung Gil Hong, Min Beom Lee et al proposed Conventional finger-vein recognition systems perform recognition based on the finger-vein lines extracted from the input images or image enhancement, and texture feature extraction from the finger-vein images [60]. Nevertheless, in these situations, poor identification of finger-vein lines reduces the precision of the recognition. In the case of extraction of texture features, the developer must decide experimentally on a form of the optimal extraction filter taking into account the image database characteristics.

Tuyen Danh Pham, Young Ho Park, et al developed a non-intrusive finger-vein recognition system using a near-infrared image sensor (NIR) and evaluated its accuracy based on different factors [61]. The experimental results obtained with three databases showed that this device can be performed in real applications with high precision and the dissimilarity of different people's fingernails.is greater than that of the finger types and hands.

A cancelable bio-cryptosystem was implemented by Wencheng Yang, Jiankun Hu, and Song Wang [62] by taking full advantage of the cancelable and non-invertible properties of bio-hashing biometry.

Kwang Yong Shin, Young Ho Park, et al proposed , the local and global features of the vein lines of an input image are amplified using Gabor filters in four directions and Retinex filtering [63]. Then this paper explained about the means and standard deviations in the local windows of the images produced after Gabor and Retinex filtering are used as inputs for the Again the optimal weights required to combine the two Gabor and Retinex filtered images are determined using a defuzzification method. Finally, the use of a fuzzy-based method means that image enhancement does not require additional training data to determine the optimal weights. Experimental results using two finger-vein databases showed that, compared to previous methods, the proposed method increased the accuracy of finger-vein recognition.

Nancy Mantrao,Sukhpreet Kaur developed Finger vein Recognition is the most current biometric innovation which uses the vein pattern which is covered up under the human finger for distinguishing proof [64]. Comparing with other traits such as fingerprint, iris and face accuracy is high in finger vein as these patterns are covered up under the skin surface, they give a colossal security thought and are difficult to forge. The best result is achieved by applying neighborhood operation and distance computation, where the accuracy can be up to 91.67%.

Young Ho Park and Kang Ryoung Park [65] proposed new image quality enhancement method that measures the direction and thickness of vein lines. This effort represents four aspects of novel research. First, as vein lines are detected in input images based on eight gray image directional profiles rather than binary images, the non-uniform detection error illumination of the finger area Second, this paper describes adaptively determines a Gabor filter for the optimal direction and width on the basis of the estimated direction and thickness of a detected vein line. Third, it is possible to obtain a clear vein image by using this optimized Gabor filter. Eventually, in the Gabor filtered image, the further processing of the morphological operation is applied and the resulting image is combined with the initial one by which the finger-vein is used a higher quality is obtained.

Christoph Kauba, Jakob Reissig and Andreas Uhl, proposed finger vein recognition preprocessing and fusion techniques An experimental study involving a number of preprocessing approaches shows how it is to choose the correct single technique and how useful it is to cascade several different preprocessing methods for subsequent processing feature extraction of various types [66].

Feifei cui, gongping yang [67] introduced multimodal biometric recognition based on fusion of fingerprints and finger-vein scales to complement one another in many respects as fingerprint recognition and finger-vein recognition. Experimental results based on the homologous biometrics database indicate that fusion of fingerprints and finger-vein results in a dramatic increase in performance. .

Sudhamani MJ,MK Venkatesha implemented Feature level fusion improves the robustness and classification accuracy compared to unimodal authentication system. This work is carried in two-folds. The first experiment contrasts the iris ' invariant numerical features with the translation, rotation and scale (TRS) finger vein. The second experiment considers the mathematical, structural and statistical characteristics of the finger vein with local and statistical characteristics of the iris [68].

Sudhamani MJ, MK Venkatesha [69] Invariant iris features and finger vein shape features are fused by the proposed method. Feature level fusion model is assessed to interpret biometric authentication system classification accuracy. The algorithm prioritizes high dimensional features by considering iris Hu-moments and finger vein shape features to achieve a secure and easy authentication system.

Through integrating k nearest neighbor with sparse representation, Shazeeda and Bakhtiar Affendi Rosdi introduced a new approach to personal identification using finger vein patterns to boost neighboring algorithms.. K numbers of best nearest neighbor samples were selected on the basis of k NN classifier in the proposed KNN-SRC method. The selected K samples were then considered to be the train samples for the Classifier based on Sparse Representation [70].

Pandillapalli Gowtham, Ch Sindhu, et al proposed a new method to improve the performance of the literature's finger-vein recognition systems [71]. At the same time, the proposed system acquires fingerprint and low-resolution fingerprint images and combines these two information using a new score-level mix technique.

Partheeba. R, N.Radha [72] data transmission was protected and user confidentiality was guarded. The two primary cryptographic schemes were secret-key cryptography and public-key cryptography. Secrecy of the cryptographic key holds the security of the system. Key management is therefore the main issue of cryptography. As a result, several key methods of generation have been developed and secured for communication privacy.

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Amruta P. Dharmadhikari, S. R. Ganorkar proposed an approach that would boost finger-vein recognition systems [73]. For the combination of score level, the minimum error distance classifier method was used. Previous systems are referred to the combination of decision level and feature level. Previous systems are referred to the level of decision and the combination of feature level. These methods often suffer from information loss. In is quite complicated and largely responsible for the individuality of fingerprints and steady the combination of score level allows each observation to operate asynchronously, which is not possible.

S. Partheeba, N. Radha [74] proposed approach to detecting fingerprint quality using the method known as Orientation Certitude Level (OCL). If the image is of good quality then Scale Invariant Feature Transform is used to extract the feature, otherwise poor quality image is ignored. Using the cover image will obscure the obtained cancelable model The secret picture will then be transmitted from sender to receiver and receiver to sender using Variable Least Significant Bit techniques. Finally the performance metrics like FAR (False Acceptance Rate), FRR (False Rejection Rate), and Accuracy of the proposed work is compared with the existing system.

Arunprakash K. Narayanan R. C, Krishnamoorthy. K proposed system using the method of K- fold cross validation by using two , a training set and test set of images to find the appropriate image that matches the input image, increase the accuracy of recognition by reducing the false acceptance rate of the system [75].

Enrique V. Carrera, Santiago Izurieta et al developed a finger-vein biometric system based exclusively on textural features to evaluate the usefulness of the remaining information around vein patterns [76]. Textural characteristics are obtained from the wavelet detail coefficients belonging to finger-vein images by means of gray-level co-occurrence matrices. The evaluation of the proposed biometric system is based on a structured finger-vein database and its results show promising changes in finger-vein authentication reliability when incorporating textural characteristics into the biometric process.

Bang Chao Liu, Shan Juan Xie, and Dong Sun Park described about two block selection methods which are based on the estimate of the amount of information in each block and the contribution of block location by looking at recognition rate of each block position to reduce feature extraction time and matching time [77].

Marios Vlachos and Evangelos Dermatas proposed method is based on the minimization of the objective function of a modified Mumford Shah Model and the local application of its results [78]. This application produces two non smooth images where veins located in concave regions. The two images are then combined simply by addition. A modified local entropy thresholding technique is used to detect concave regions. The preliminary segmentation result was unsatisfactory due to the presence of some outliers (misclassifications). Thus, a final morphological post processing step followed in order to clean the image from the misclassifications and to produce a robust finger vein pattern.

Huafeng Qin and Mounim A. El-Yacoubi [79] proposed a deep neural network (DNN) for representation learning to predict image quality using very limited knowledge. Driven by the primary objective of biometric performance evaluation, i.e. minimizing verification failure, we believe that low-quality images in a verification system are wrongly rejected.

Yu Lu, Sook Yoon and Dong Sun Park proposed system can generate more discriminative information by fusing information from two simultaneous captured images and can enhance the matching accuracy. Experimental results obtained using a database set up by the authors containing 436 fingers from 109 subjects confirm the viability of the proposed system [80].

Randa Boukhris Trabels, Alima Damak Masmoudi, et al [81] implemented a new multimodal biometric system based on fusion of both hand vein and finger vein modalities. For finger vein recognition, the proposed system employ the Monogenic Local Binary Pattern (MLBP), and for hand vein recognition an Improved Gaussian Matched Filter (IGMF). Experimental results support the excellent identification quality of the proposed multimodal biometric method compared to the unimodal biometric system. The suggested approach's Area Under Curve (AUC) is very similar to unity (0.98).

Makram Nabti, Lahouari Ghouti and Ahmed presents a multiscale edge detection approach has been employed as a pre-processing step to efficiently localize the iris followed by a new feature extraction method based on some multi scale extraction techniques. This mixture uses special Gabor filters and total wavelet components. This combination uses Gabor special filters and peak wavelet components. Finally, a promising feature vector representation using moment invariants is proposed [82].

Huanfeng Qin and Mounim A.El Yacoubi, [83] proposed a deep learning model to extract and recover vein features using limited a priori knowledge. First, two regions will automatically identify a particular region with high finger-vein separability patterns and context based on a combination of state-of - the-art finger-vein image segmentation techniques as Secondly, on the resulting dataset, a Convolutionary Neural Network (CNN) is trained to predict the probability of each pixel of being foreground. Thirdly, by creating and analyzing a Fully Convolutionary Network (FCN), the author proposes another new and initial contribution to the recovery of missing finger vein patterns in the segmented image.

Khattab M. Ali Alheeti, implemented the iris recognition approach is implemented via many steps, these steps are concentrated on image capturing, enhancement and identification [84]. Different types of edge detection mechanisms Canny scheme, Prewitt scheme, Roberts scheme and Sobel scheme are used to detect digital image iris boundaries in the eyes. The implemented system gives adequate results via different types of iris images.

Faris E.Mohammed, Eman M. ALdaidamony, A. M. Raid, [85] explained the proposed system fuse personal finger vein and iris which utilizes a vein feature matcher for finger vein and Hamming Distance Matcher for iris with matching score level to provide higher accuracy of 92.4%, with FAR and FRR of 0% and 7.5%, respectively.

Law Kumar Singh, Praveen Gupta, proposed a personal identification using iris recognition system with the help of five major steps i.e.

image acquisition, segmentation is performed using Canny Edge Detection and Hough Transformation, normalization, feature extraction using Local Binary Pattern and matching and also these five steps consists a number of minor steps to complete each step. The pupil and limbic boundaries are detected using Canny Edge Detection and Circular Hough Transformation [86].

Mohammad Aakif Kausar, Gautam Purwar [87] delivers a iris coding method for effective recognition of an individual. An algorithm that is based on person iris independent of spatial position, orientation and center frequencies of the iris image. The fact that the iris is protected behind the eyelid, cornea and aqueous humor means that, unlike other biometrics such as fingerprints, the likelihood of damage and/or abrasion is minimal.

Sachin S.Bhosale, Rakesh P.Kumawat, illustrates techniques to improve performance of iris recognition system based on stationary image. In this paper the author focused on an efficient methodology for identification and verification for iris detection. The iris recognition approach is implemented via many steps these steps are concentrated on image capturing, enhancement and identification [88].

Habibah Adamu Biu,Rashid Husain and Abubakar S.Magaji [89] proposed Iris recognition is considered to be one of the best and accurate form of biometric measurements. Iris recognition and authentication has a major problem in its code generation and validation accuracy to improve the authentication process by producing a binary bit sequence of iris which contains many vital information used to measure the Mean Energy and Maximum Energy which goes into the eye with the Threshold Value adopted. The information generated can further be used to find out different eye ailments.

R.Shanthi, B.Dinesh proposed to implement an iris recognition system, where circular Hough transform and Canny edge detection is used to segment the iris region. Using the Daugman algorithm, a model of the detected area is generated and the template matching for identification is based on the distance from Hamming. The results shows that the proposed method is efficient for iris based biometric recognition [90].

A. Srinivasan and S. Sundaram, [91] proposed Medical imaging plays important role for the practice of medicine globally and is rapidly increasing and getting sophisticated day by day. But accurate, fully automatic medical image analysis continues to be an elusive ideal for quantitative exploitation for diagnosis and therapy. The paper reviews the application of deformable models as a capable and robustly applied digital medical image analysis technique of the human body.

K. Saraswathi, B. Jayaram and R. Balasubramanian, developed an approach for network security by means of biometric [92]. Human biometrics such as hand morphology, eyes, fingerprint, retina, iris, DNA, signature and speech can be used effectively to guarantee network security The different phases included in this proposed approach are user registration, Extraction of minutiae points and secret key, Iris localization and Normalization.

A new biometric finger system was developed by Eui Chul Lee, Hyunwoo Jung, and Daeyeoul Kim [93]. Infrared finger images are obtained and then analyzed using a modified Gaussian highpass filter using binarization techniques, local binary patterns (LBP) and local derivative patterns (LDP).

Xiaoming Xi, Gongping Yang et al proposed a simple but powerful feature, called Pyramid Histograms of Gray, Texture and Orientation Gradients (PHGTOG). PHGTOG can reflect the global spatial layout and local gray, texture and shape details for a finger vein image. To further improve the author, use the sparse weight vector trained with LASSO, called PFS-PHGTOG, to select a custom subset of PHGTOG features for each subject. Detailed studies are conducted by the researcher to demonstrate the potential of PHGTOG and PFS-PHGTOG, experimental results indicate that PHGTOG exceeds the other current characteristics [94].

S.Kalaiselvi, R.Anandha Jothi [95] proposed advancements in research methodologies used by different researchers for iris localization, iris segmentation, feature extraction, and classification and encryption of the Iris images.

Several machine learning techniques SVM, neural network, and fuzzy logic) were used in the biometrics extraction and matching function process. Such kinds of techniques have also been shown to be effective in extracting, matching and enhancing the Finger Vein Recognition system efficiency. Machine learning classifier-based methods were used in most techniques of Finger Vein Recognition during the matching stage of Finger Vein Recognition. Yet conventional approaches to the finger vein use distance-based methods during the matching process. Nearly 100 percent of the proposed machine learning vein algorithms are accurate [96], [97], [98], [99].

Binsu c kovoor, supriya m.,poulose Jacob[100] proposed Daugman method is done to investigate the segmentation techniques. Eyelid detection is another step that has been included in this study as a part of segmentation stage to localize the iris accurately and remove unwanted area that might be included. The iris area obtained is encoded using hair wavelets to create the iris code, which includes the most discriminating attribute in the iris pattern. Hamming distance is used in the recognition stage to compare the iris templates. The dataset which is used for the study is UBIRIS database.

A comparative study is carried out with the different operator of the edge detector. It is observed that canny operator is best suited for extracting most edges for comparison to generate the iris code. The recognition rate is 89% and the refusal rate is 95%.

Fig. 1. S. Ilankumaran C.Deisy proposed a new C2 code derived from finger vein and iris images with orientation and magnitude data to enhance the authentication system [101]. The C2 software removes the system complexity reduction function selection operator because it combines the orientation and magnitude of the finger vein inputs with the iris picture. Due to its reduced data handling difficulty, this technique can be applied in a cloud computing environment-based biometric authentication system.

VI. PERFORMANCE ANALYSIS

In this section, explains about the summary and comparison for all methods about the size of used databases, the equal error rate (EER) or recognition rate (RR), and processing time, shown in Table .

From the table, we can see that some methods, for example, Local Derivative pattern, Repeated Line tracking and Special line tracking report promising performance. At the same, there are two problems: (1)The size of databases are general limited, so it cannot be predict how the performance will be on a large scale database; (2)The processing time is long, although they can be used in real time applications. Table shows that comparison of finger vein and iris based authentication methods.

Table Comparison of finger vein and iris based authentication methods

Author	Year	Method	Performance
Eui chullee, et al. [93]	2011	Local Derivative Pattern method	Error Rate=0.13%
Zhi Liu and Shangling Song [46]	2012	Digital Signal Processor platform and equipped with a novel finger-vein recognition algorithm	Error Rate – 0.07%
Xiaoming Xi,et al. [94]	2013	i).PHGTOG Feature Extraction and ii).PFS-PHGTO G Feature Extraction	i).PHGTOG: EER=0.0353 Recognition Rate=0.9765 ii).PFS-PHGTOG: EER:0.0110 FAR at-Zero-FRR=0.3680 FRR at-Zero-FAR=0.080 1
Faris E. Mohammed, et al. [85]	2014	Multi modal Biometric identification system	FAR and FRR of 0% and 7.5%, respectively.
Nagasaka [11]	2004	Special Line Tracking	Equal Error Rate=0.145%
Habibah Adamu Biu ,et al.[89]	2018	Mean and Maximum energy measure	FAR=1% FRR=1%

VII. RESULTS AND DISCUSSION

Figure.7 Palm Vein Segmentation

A DOG filter and histogram equalization, is adopted to alleviate uneven illumination and to highlight vein textures. RootSIFT, a more stable local invariant feature extraction method in comparison to SIFT, is adopted to overcome the projection transformation in contact-free mode. Subsequently, a novel hierarchical mismatching removal algorithm based on neighborhood searching and LBP histograms is adopted to improve the accuracy of feature matching. Finally, we rigorously evaluated the proposed approach using two different databases and obtained 0.996% and 3.112%.

VIII. CONCLUSION AND FUTURE WORK

This paper provides a comprehensive analysis of traditional approaches to finger vein recognition focused on machine learning and deep learning. The approach to light transmission is considered to be the best way to capture the image in photo processing of high quality. In the preprocessing of images, methods for extraction of region of interest and methods for enhancing images are checked. In addition, the conventional extraction methods for features were classified into five groups (i.e., vein-based method, iris-based method, binary-based local method, dimension-based method and minutiae-based method). There were both examples of distance-based matching methods as well as classification-based matching methods for the matching stage. This paper discusses about finger vein and iris based biometric authentication system. The steps involved in this authentication system and techniques used for identification is discussed. Among various methods self adaptive illumination control based finger vein authentication system provides better performance than others. The future work is to focus on growing new procedure keeping in mind the end goal to enhance coordinating of finger vein and iris extraction of example precisely and decrease the rate of misclassification by joining two are three best techniques.

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AUTHORS PROFILE

K. Appasamy, has received the MCA degree from Manonmaniam Sundaranar Unviersity of India in 2007 and the M.Phil degree from Manonmaniam Sundaranar Unviersity of India in 2008. He is currently doing Ph.D degree in the Department of Computer Science at Vinayaka Mission's Kirupananda Variyar Arts and Science College, Salem. His research interests are Bio Medical Image Processing and Biometrics Authentication System.

Dr. R. S. Shanmugasundaram, has received the BE degree in Electronics and Communication Engineering from the University of Madras of India in 1996, ME degree from the Bharathidasan University of India in 2001 and Ph.D degree from Anna University of India in 2015. His research interest are in medical image processing, deformable models and segmentation. He is a life member of ACS and ISTE. Currently he is working as Deputy Director (Academics) of Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India.