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Title **PALMENTIC PALM AUTHENTIC : CONTACTLESS AUTHENTICATION TECHNOLOGY TO RECOGNIZE INDIVIDUAL**

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PalmEntic Palm Authentic : Contactless Authentication Technology to Recognize Individual

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Abstract
Palm Vein Recognition is one among the biometric authentication methods. It works by recognizing the unique patterns of veins in the palms of the people. Generally, veins carry deoxygenated blood from tissues to the heart. In palm vein recognition, the near-infrared light is illuminated into the palm emitted by the palm scanner. This near-infrared light is absorbed by the deoxygenated blood flowing through the veins which reduces its ability to reflect back the light. This causes the veins to appear as black patterns and is captured as an image by the scanner. These images are processed using various algorithms and compared with the data in the database and authenticates the individuals. In this work, we are using a Mutual Foreground based Local Binary Pattern algorithm for the processing of palm vein images. Local Binary Pattern (LBP) is an efficient texture representation of an image, but when used to describe the sparse texture in palm vein images, the discrimination ability is diluted, leading to lower performance, especially for contactless palm vein matching. In this work, an improved Mutual Foreground LBP method is used for achieving a better matching performance for contactless palm vein recognition. First, the palm print images are pre-processed. The aim of pre-processing is to enhance the features of the palm image for better analysis and further processing. The k-means algorithm is utilized for removing noise, texture extraction, improves accuracy and robustness. Later we will find the Region of Interest (ROI) which plays a vital role in maintaining tolerance. Then, a Mutual Foreground based LBP matching strategy is adopted for identifying the similarities on the basis of extracted palm veins. LBP contains relative values obtained by comparing each pixel with its neighboring pixels. In addition, we adopted the matched pixel ratio (MPR) to find the best matching region (BMR), which can further improve the performance of LBP matching. Third, the matching score obtained in the process of finding the BMR was fused with the results of LBP matching to further improve the identification performance. Then, an improved Chi-square distance is proposed to increase the computational efficiency. Finally, the person is authenticated and shows whether he/she is allowed to access the device.

Keywords: Palm Vein Recognition, Local Binary Pattern, mutual foreground, infrared light, palm, palm veins, patterns,pre-processing.

Introduction

Earlier, we had only passwords and swiping cards for allowing a person to access something. With the increasing financial activities and security awareness, traditional authentication such as password, swiping cards, identification numbers have been largely incapable of meeting the requirements of convenience, reliability and security. Owing to their limitations now we are making use of biometric identification. Biometric identification uses human characteristics for authorizing an individual. Biometric identification includes fingerprint recognition, iris recognition, face recognition, retina recognition, hand geometry, voice recognition, DNA, ear biometrics, etc. Among these, facial recognition is popular for identifying a person with a clean background. But it becomes a problem when the face is obstructed by facial hair, other body parts, googles, scars etc. Fingerprint and palmprint

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identification are also widely used techniques. But they have to come in contact with the sensor, which is regarded as unsanitary and sometimes leads to wrong results because of the former impressions present on the sensor. The accuracy is also affected by external matters like dust, moisture, water, oil, etc. Iris recognition is highly secure but the cost of the scanner and the installation is unacceptable and eyes are also exposed to Infrared Rays for more than 10 secs each time we try to authorize, which is very harmful to our eyes. In addition to these, extrinsic biometric traits such as handwriting or signature can be spoofed which affects the privacy and security and intrinsic biometric characteristics such as palm vein patterns and DNA are difficult to forge as they are present deep inside the body. Among all these, Palm Vein patterns are more efficient and easier to acquire. Palm vein patterns are complex network-like structures. They are present below the skin and invisible to the human eye under natural lightning conditions. They can be seen only when the infrared light emitted by the scanner is illuminated. A Palm vein scanner works by using infrared light to map the unique vein structure of the palm, capturing over 5 million data points. The vein patterns are different for each and every individual. Even the identical twins have different palm vein patterns. These features of palm veins effectively protect against spoofing, external damage, etc. This work consists of mainly two phases, whilst the first is the training phase and the second is testing phase. Training phase consists of input, pre-processing and feature extraction. The input palm vein image is pre-processed. Firstly, Pre-processing consists of Image background index estimation in which the RGB (Red Green Blue) image is converted to its corresponding binary value and this process is known as thresholding that is done by checking the index value present in the image and the index value of the background is estimated for the purpose of noise removal. Next to the index estimation, Region of Interest (ROI) is estimated. We find ROI by identifying the junction points of palm vein image i.e., point between index and middle finger, and point between middle and ring finger as such, and by arranging these points in ascending or descending order we get our extreme points, then we plot a square or rectangle by joining these extreme points. ROI estimation is followed by Skewed operation, in which the obtained square is rotated by an angle theta. Finally, histogram of skewed corrected image is taken and contrast of image is enhanced and histogram equalization is performed and normalized the palm vein image. Next phase in training is feature extraction. Features are extracted from the images using K-means and MF LBP algorithms. These features are stored in the database. In the testing phase, the image captured by the scanner is also pre-processed and features are extracted similar to that of the training phase. A histogram is plotted with the LBP values obtained in the feature matching phase. Euclidean distance between the veins is calculated. Now, the mean of the Euclidean distance is obtained. This means of Euclidean distances and the roll number are given as input for authorizing the individual. These inputs are compared with the information in the database and gives the output as whether the person is authorized or not

I. LITERATURE SURVEY

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- Research on Palm Vein Recognition Algorithm Based on Improved Convolutional Neural Network is proposed by Bo Sun, et al.[1] When collecting palm vein images, it is easy to be affected by external factors such as light source and placement angle, which result in poor recognition accuracy. A new method, which involves a new method of region of interest segmentation and an improved palm recognition method of VGG16 deep convolutional neural network, was proposed to promote the recognition accuracy and be well adapted to the actual application scenarios. Firstly, the original palm vein image is obtained through profile original image, positioning key point of original image, and extract region of interest image. Afterwards, the adaptive histogram equalization technique and Gaussian Filters are utilized to improve image quality. Secondly, for palm vein image recognition application scenarios, the output of the convolutional layer of the VGG-16 convolutional neural network is standardized in batches, and the attention mechanism is introduced to optimize the VGG-16 neural network. Thirdly, data enhancement was performed on the public PolyU multispectral palm vein data set, and then a large number of experiments were carried out, and the best recognition rate was 99.57%.

- Hoang Thien Van, et'al [2] proposed Palm Vein Recognition Using Enhanced Symmetry Local Binary Pattern and SIFT Features. The palm vein feature extraction method for contactless palm vein recognition is based on combining enhanced center-symmetric local binary pattern (ECS-LBP) with SIFT, called EL-SIFT. The proposed method includes two steps in which step 1 is applying ECS-LBP to detect stable and clear palm-vein lines and step 2 is extracting SIFT feature on palm vein lines image. The experimental results on the public contactless palm vein databases (CASIA Multispectral Palm vein Image Database V1.0) show that our proposed method is accurate and robust for palm vein recognition in comparison with other approaches in the literature.
- Palm Vein Recognition Using Convolution Neural Network Based on Feature Fusion with HOG Feature is proposed by Xiaolin Ma, et'al.[3] Palm vein recognition has become a popular research in biometric recognition due to its unforgeable characteristics. Aiming at the complex design of palm vein recognition based on traditional feature engineering methods, this paper proposes to use the deep features of convolutional neural networks fused with hog features to identify palm vein. Experiments show that this method has achieved both higher speed and accuracy on two different databases, which achieves the recognition accuracy of 99.25% on CASIA and 99.90% on PolyU respectively.
- Competitive Coding Scheme based on 2D Log-Gabor filter for Palm Vein Recognition is proposed by Larbi Boubchir, et'al. [4]The proposed method consists of two major steps in which the first step is inspired by the bitwise competitive coding, the feature extraction employs 2D log Gabor filtering where the final feature map is composed by the winning codes of the lowest filters' bank response and second step is the matching process which uses the Jaccard distance as a metric to capture efficiently the similarities between the feature maps and allowing to make a decision. MS-Polyu databases have shown that the proposed method yields significant performance gains compared to existing state-of-the-art methods.
- Lightweight and Privacy-Preserving Template Generation for Palm-Vein-Based Human Recognition by Fawad Ahmed, et al [5]is a wave atom transforms (WAT)-based palm-vein recognition scheme. The scheme computes, maintains, and matches palm-vein templates with less 5 computational complexity and less storage requirements under a secure and privacy-preserving environment. First, we extract palm-vein traits in the WAT domain, which offers parser expansion and better capability to extract texture features. Then, the randomization and quantization are applied to the extracted features to generate a compact, privacy-preserving palm-vein template. The extensive experimental results demonstrate comparable matching accuracy of the proposed scheme with a minimum template size and computational time of 280 bytes and 0.43 s, respectively.
- An Automated Biometric Identification System Using CNN-Based Palm Vein Recognition proposed by Sin-ye Jhong, et'al[6] is palm vein recognition that provides accurate results and has received considerable attention. They developed a novel high-performance and noncontact palm vein recognition system by using high-performance adaptive background filtering to obtain palm vein images of the region of interest. Then used a modified convolutional neural network to determine the best recognition model through training and testing. Finally, the developed system was implemented on the low-level embedded Raspberry Pi platform with cloud computing technology. The results showed that the system can achieve an accuracy of 96.54%.
- Segmentation of Palm Vein Images Using U-Net by Waleed H. Abdulla, et'al [7]is a Convolutional Neural Network (CNN); U-Net, to effectively segment the vein networks from the background of near-infrared palm vein images. The experiments were conducted on the HK PolyU Multispectral Palmprint and Palm vein database. The original images taken from the database were reduced to regions of interest. Morphological operations were applied to obtain ground truth mask images. The mask images were then used to train a modified U-Net in which a Gabor filter was applied in the first block of the U-Net architecture. The accuracy of the segmented vein images was obtained by determining the overlap between the segmented images obtained from the network and the corresponding ground truth images from the morphological operations. The overlap is evaluated using the Jaccard Index and Dice Coefficient Metrics. For both

of these similarity metrics, the value 0" indicates no overlap and 1" indicates a complete congruence between the subject images.

- Shi Chuan Soh, et'al [8]proposed Image Fusion based Multi Resolution and Frequency Partition Discrete Cosine Transform for Palm Vein Recognition. The fusion of multiple images is able to provide richer feature information resulting in an improved classification performance. However, although most of the image fusion techniques are able to preserve the vein pattern, the fused image is often blurred, the colors are distorted and the spatial resolution reduced.in this the multiresolution discrete cosine transforms (MRDCT) and frequency partition DCT (FPDCT) image fusion is applied and are able to extract the finer details of vein patterns while reducing the presence of noise in the image. The performance shows that the use of MDCT and FPDC was able to improve recognition rate compared to using a single image. The equal error rate improvement is also significant, falling to 9% in the 700nm image, 7% in the 850nm image and 6% in the 940nm image.
- Vein Biometric Recognition on a Smartphone by Raul Garcia-martin, et'al[9] is a novel wrist vascular biometric recognition that is designed, implemented, and tested on the Xiaomi Picophone F1 and the Xiaomi Mi 8 devices. The near-infrared camera mounted for facial recognition on these devices accounts for the hardware employed. Two software algorithms, TGS-CVBR and PSVR, are designed and applied to a database generation and the identification task, respectively. The database, named UC3M-Contactless Version 2 (UC3M-CV2), consists of 2400 contactless 6 infrared images from both wrists of 50 different subjects collected. The vein biometric recognition, using PIS-CVBR, is based on the SIFT, SURF, and ORB algorithms. The results, discussed according to the ISO/IEC 19795-1:2019 standard, are promising and pave the way for contactless real-time-processing wrist recognition on smartphone devices.
- Identification of individuals using palm vein classification by Hussien Kannan, et'al[10] is a palm identification using Gabor filter. method processes images using Gaussian filter and histogram equalization methods. The features are then extracted using a bank of Gabor filters. They apply the L2- max norm of superposition into the output of the Gabor filter to reduce the dimension of the features vector. Finally support vector machine (SVM) and Nearest Neighbors classifiers are used for palm vein verification. The proposed method is evaluated using a public dataset, named VP. The efficiency of the identification process by the proposed methods is highly compared to the traditional one where simplified extraction features methods are used. The experimental results confirm that the introduced approach is efficient compared to the traditional methods.
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Swati Rastogi, et'al [11] proposed 850nm near-infrared (NIR) palm vein pattern imageries are considered and have been successfully recognized utilizing image processing in machine learning. The proposed method has well combined the ROI extraction, feature extraction to stipulate the desired response. The palm vein images are enhanced and denoised using a median filter. The Otsu Binarization is applied and finally, the 850nm NIR palm vein pattern collective imageenabled dataset has been successfully recognized. Various palm vein features extraction and correction are done to establish the quantification between the test data and the trained data. Hence, amalgamating the power of image processing in machine learning and Python programming, the proposed novel palm vein pattern for personal recognition method is designed which provides a user-friendly environment. Enhancing bank security systems using face recognition, Iris Scanner and Palm Vein Technology proposed by Hemant Jain, et al [12]is to design a bank locker security system for securing valuable belongings. A face recognition system is a system which identifies and authenticates the image of the authorized user by using MATLAB software. The images of a person entering an unrestricted zone are taken by the camera and software compares the image with an existing database of valid users. The Iris Recognition system uses generous characteristics present in the human body. The capability of the palm vein recognition system can be improved using modified vascular pattern thinning algorithms. Palm Vein Recognition (PVR) is a technology which recognizes the palm vein pattern of an individual and matches it with the data stored in a database for authentication. This is a very reliable technique and has a very good accuracy and is considered as the most secure and better technique for security purposes.

- Fuzzy Rider Optimization Algorithm for vein-based biometric recognition system proposed by Dipti Verma, et'al [13]is the model for vein-based biometric recognition using the rider- based score level fusion method. The developed method includes four steps, which are pre-processing, vein extraction, feature extraction and biometric recognition. The first step is to input the training images, like finger, hand, and palm into a pre-processing step. In the pre-processing level, noises are removed from the input image and the Region of Interest (ROI) extraction is also executed in the pre-processing module based on the neighborhood search method. Entropy-based Euclidean 7 Distance (EED) is developed for score level fusion. At last, the biometric identification is carried out based on the proposed Fuzzy Rider Optimization Algorithm (Fuzzy ROA). The performance metrics, such as False Rejection Ratio (FRR), False Acceptance Ratio (FAR) and accuracy are analyzed, and then compared with other methods. The evaluation of the developed method attains the maximum accuracy of 90.19%, minimum FAR and FRR of 10.09% and 0.87% respectively.
- Palm vein pattern: Extraction and Authentication by Swati Rastogi,et al[11] is the unique approach towards the extraction and authentication of 850 nm near-infrared palm vein pattern developed in this research. The Bank of Gabor filter, which contains 8 Gabor filters in a single bank, is developed along with the Sobel kernel filter to accomplish the desired outcome. Applying the proposed methodology, near-infrared palm vein pattern extraction is efficiently implemented. Random Forest and Gaussian Naïve Bayes classifiers are used to acquire the accuracy scores to procure matching. Accuracy scores obtained by the near-infrared palm vein classifier is 97.40% for the Random Forest classifier and 96.30% for the Gaussian Naïve Bayes classifier. The created framework can be joined with different applications, such as record-keeping, interruption identification, qualification confirmation for business exchanges, misrepresentation assessment, and identity verification.
- Multibiometric Authentication System Using Slap Fingerprints, Palm Dorsal Vein, andHand Geometry by Puneet Gupta, et'al[14] is a system which simultaneously acquires slap images and infrared (IR) hand dorsal image from which slap fingerprints, palm dorsal veins, and IR hand geometry are extracted. Simultaneous acquisition reduces the acquisition time and helps to improve user acceptability. The slap segmentation is accomplished using the knowledge of the approximate finger location and hand type (either left or right) obtained from the simultaneously acquired IR hand dorsal image. Multibiometric fusion based on serial methodology has been proposed for consolidating the matching scores of slap fingerprints, palm dorsal vein, and IR hand geometry. Results indicate that authentication using slap fingerprints can be improved by incorporating the knowledge from IR hand images.
- Reversible Palm Vein Authenticator Design With Quantum Dot Cellular Automata for Information Security in Nano Communication Network by Jadav Chandra das, et'al[15] is a developing field of nanotechnology which facilitates the creation of nano-scale logical circuits. Irreversible technology has faced some difficulties, such as higher heat energy dissipation. Reversible logic is therefore essential where heat dissipation is almost insignificant. QCA design of a reversible circuit for palm vein authentication utilizing the Feynman gate. Fully reversible Feynman gate is designed. Using this newly designed Feynman gate the palm vein authenticator circuit is designed. The theoretical values and the results of the simulation correspond to the reliability of the planned circuit. Energy dissipation of the proposed designs shows that it remains within Launderer's limit (0.06meV). This proves that the circuits designed are fully reversible in nature and dissipates very less amount of energy. Comparison with recent QCA state of the art architectures explores its characteristics.
- Rajalakshmi M, et'al [16]proposed a Performance evaluation of various filters

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for Noise removal on near Infrared Palm Dorsal Vascular Images. They need to adapt and apply an effective image denoising technique to arrive at a good classification of data collected in an uncontrolled environment thereby improving the recognition accuracy. This uses the venal structure that is commonly studied today amongst the biometric features for the purposes of authentication and recognition. The acquired image contains noise that results in the identification of false veins, thus 8 illustrating the need for an enhanced technique of denoising. Present the performance evaluation of different image denoising filters, by adding some Gaussian noise to find out that the optimum filter which clearly discriminates against the hand vein skeleton and effectively denoises the image. In this study, the filters were tested on a database of 250 subjects, in which five different dorsal hands related images were taken for each individual, and yielded promising results. The result of the evaluation shows that High Boost Filter with histogram equalization performs reasonably better as Image denoising filter and presents the image in an enhanced manner compared to all other filters.

- Palm vein recognition, a review on prospects and challenges based on CASIA's dataset proposed by Ali Salman, et'al[17] is a Biometric that relies on behavioral and physiological characteristics such as recognition based on palm veins to provide maximum protection and avoid unauthorized access to our personal property. In this, they are biological properties that do not change over time, and each person has his own pattern of veins, even symmetric twins have different patterns. These veins are not seen with the eye, which is difficult to forge and steal as the pattern of veins is extracted by near infrared rays. Palm veins images are considered one of the most promising technologies that meet the advanced safety requirements of modern privacy policies for highly sensitive systems. The authentication system through palm veins is generally content from four steps, namely acquisition of image, pre-processing, extraction of feature and feature matching. In each stage, there is a set of methods used in this research.

II. METHODOLOGY

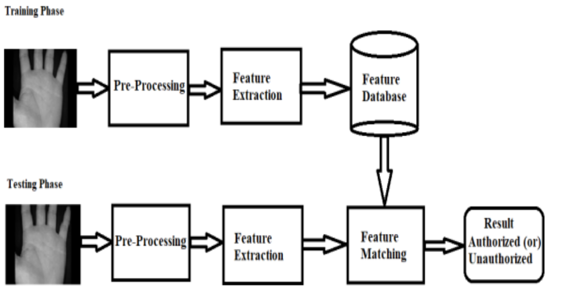

figure III. Block diagram

The dataset is divided into two phases. They are in the training phase and the testing phase. In each phase pre-processing of image is performed to enhance the quality of the image. The next step is to extract features which can be done by using k-means and results are stored in a database. Now the extracted features can be matched using Local Binary Pattern to know whether the user is authorized or not.

A. Providing Input:

The first and the foremost step in any of the models is to provide the input. There are many kinds of input such as text, numbers, images etc., depending on the type of the problem. As our problem is palm vein recognition, we are taking the images of the palms of the people as input to our problem. The CASIA multi spectral palmprint image database, containing 600 images collected from 100 individuals is used as the input dataset.

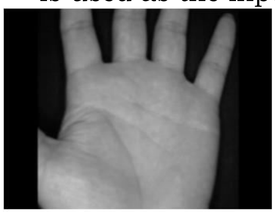

Figure III.A. Pre-processed Image

B. Pre-Processing:

Input Image Data pre-processing is an important step in development of any model as the quality of data and the useful information that can be derived from it directly affects the ability of our model to learn. So, it is extremely important that we pre-process our data

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before feeding it into our model. Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of processing in which input is an image and output may be image or characteristics or features associated with that image. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are preprocessing, enhancement, and display, information extraction. The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further pre-processing. The first step is to convert the RGB image into a grayscale image because the gray scale image is a layer image from 0 to 255 whereas the RGB has three different layers. So that is a reason we prefer grayscale images instead of RGB. The next step is to separate the background. The background is separated by masking the foreground. Background subtraction is a technique for separating our foreground elements from the background and is done by generating a foreground mask. The next step is to extract ROI. The ROI extraction is a major task in the palm vein identification. The ROI 16 extraction refers to carrying out a series of adjustments and key points location for palm vein images, then the effective area of center is selected to extract the features, and final matching is carried out for the recognition. This central region is usually called the region of interest (ROI), for the palm vein image of the same palm, the location of ROI should be the same. The purpose of ROI location and selection is to get sub images including rich information of palm vein extraction, which is convenient for the subsequent feature extraction and matching. Our proposed palm vein ROI segmentation is used to extract hand contours from grayscale palm vein images. Next, the distance between the reference point and contour points was used to locate the peak points and valley points of the palm, which can be taken as landmarks for extraction of ROI from grayscale palm vein images. Finally, we perform scaling and rotation normalization on the extracted ROI to obtain the final palm vein ROI to be matched.

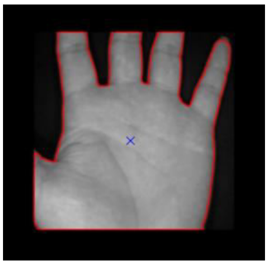

Figure III.B. Input Image

C. **Feature extraction**:

K means method is used for feature extraction. Basically, our input image is divided into segments containing different kinds of data like, the background, skin of our palm, veins, bones each having different intensities... With the help of the K -means algorithm we will make them into clusters where k indicates the number of clusters. Now we will select k centroids and assign each data point to their closest centroid. And then we have to calculate the variance and place a new centroid for each cluster. And repeats the previous process, which is reassigning and calculating the variance. And finally, we stop this process if there is no reassignment, then send the mean value of the vein clusters to the database for the additional processing. Region of interest which is in the form of pixels calculated in the pre-processing is taken as input for feature extraction. First a 3x3 matrix of random integer values is considered, this matrix contains the centroid values of each cluster. Later distance from each pixel in ROI to all three centroids is calculated and the current pixel is assigned with the value of nearest centroid. Here, we are grouping similar kinds of pixels. This process is repeated for all the pixels of the image.In the

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next iteration new centroids are chosen and the same steps are repeated as earlier. After completion of all the iterations we will get a clustered image which categorizes the ROI image into skin, vein, bones etc respectively... Loss in our system is calculated after each iteration. Here, loss is the number of pixels which are present out of the bounds or the pixels having the same distance value for more than one centroid, etc., The loss value decreases with increase in the number of iterations.

Figure III.C. Clustered Image

D. Feature Matching:

Clustered Image Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Using the LBP combined with histograms we can represent the palm vein with a simple data vector.

LBP uses four parameters:

1. Radius: the radius is used to build the circular/square local binary pattern and represents the radius around the central pixel. It is usually set to 1.
2. Neighbors: the number of sample points to build the circular/square local binary pattern. It is usually set to 8.
3. Grid X: the number of cells in the horizontal direction
4. Grid Y: the number of cells in the vertical direction. Suppose we have a palm image in grayscale.

We can divide the image into a window of 3x3 pixels. It can also be represented as a 3x3 matrix containing the intensity of each pixel (0-255). Then, we need to take the central value of the matrix to be used as the threshold. This value will be used to define the new values from the 8 neighbors. For each neighbor of the central value (threshold), we set a new binary value. We set 1 for values equal or higher than the threshold and 0 for values lower than the threshold. Now, the matrix will contain only binary values (ignoring the central value). We need to concatenate each binary value from each position from the matrix line by line into a new binary value. Then, we convert this binary value to a decimal value and set it to the central value of the matrix, which is actually a pixel from the original image. At the end of this procedure (LBP procedure), we have a new image which better represents the characteristics of the original image.

Figure III.D. LBP Image

E. Verification:

LBP Image Now, we will extract the histograms using the image generated in the last step. As we have an image in grayscale, each histogram will contain only 256 positions (0-255) representing the occurrences of each pixel intensity. The final histogram represents the characteristics of the original image.

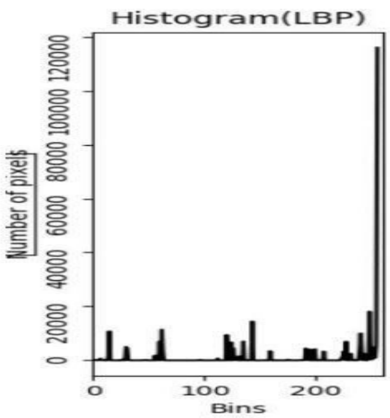

Figure III.E.1 Histogram for LBP values

Through the histogram computation described above, an effective description of the palm vein was formed, LBP code for

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the histogram contains information about pixel-level micropatterns, LBP code distribution in different bins over a subregion produces spatial information on a regional level, and regional histograms are concatenated to build a global description of the palm vein. Based on this description, we can calculate the Euclidean Distances between the pixels containing the veins, and then we calculate the mean of these Euclidean distances.

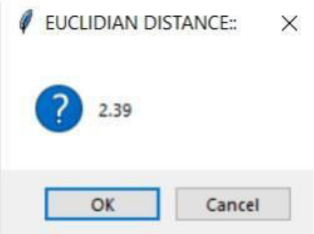

Figure III.E.2. Mean of Euclidean Distances(Sample image representing Mean of Euclidean Distances)

With the help of roll number and the mean of the Euclidean distances, we can verify the user. A label is displayed which contains the information as authorized or unauthorized.

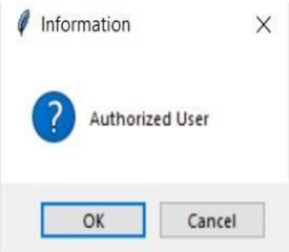

Figure III.E.3. Authorized user (Sample image representing Authorized user)

Authorized users are given access to the device or the highly secured area, whereas the unauthorized user's access is denied.

Figure III.E.4. UnAuthorized user (Sample image representing UnAuthorized user)

III. EXPERIMENTAL RESULTS

Initially in the registration page, we have to give all the details of the user such as roll number, first name, last name, mobile number, city, state and age. After entering the details of the person, we have to upload the respective palm image of that person. Palm images can be uploaded by clicking on the palm button.

As soon as the image is uploaded, processing of the image takes place. Below given image is the original palm image that is selected from the dataset and given as input

Figure V.1. Original palm image (Sample image taken from CASIA dataset)

The input palm image is pre-processed, in which it is converted to grayscale image. Later, the grayscale image is taken and the foreground or background subtraction is performed according to the requirement of the system. For our work, we have to subtract the background of the image. This is done by masking the foreground. After subtracting the background of the image, we have to identify the contour of the palm and calculate the region of interest. After pre-processing, Feature extraction takes place. For the purpose of feature extraction, we have used K-means clustering. Clustered image is taken as input to the Feature matching phase. Here we will make use of the Local Binary Pattern algorithm for the process of feature matching. Later, with the help of LBP values we will plot the histogram. In the below figure, we have calculated the LBP values for the clustered image and histogram is plotted for those LBP values. Now, we have calculated the Euclidean distances between the pixels containing the veins with the help of LBP values and the mean of Euclidean distance is taken as the ID of that individual. Below is the image representing an example of the output

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obtained after calculating euclidean distance.

Figure V.2. Mean of Euclidean Distances

In the login page, the data fields we have to enter the details such as roll number and mean of the Euclidean distance which acts as key to the locked device or highly secured area, and we have a login button and palm button. By clicking on the palm button, we can get the Euclidean distance and by clicking on the login button, the person is authenticated and if that person is a legitimate user a notification showing as Authorized pops on the screen, else it shows that the user is unauthorized.

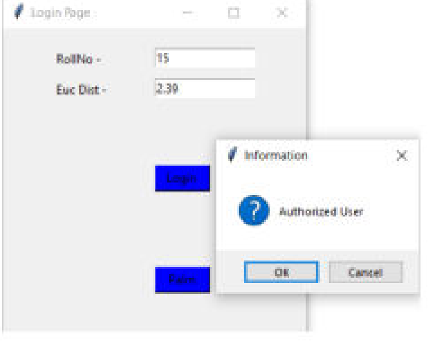

Figure V.3. Authorized user (Sample image representing authorized user)

Entering the wrong details, shows us that the user is Unauthorized and the access is denied for unauthorized users as discussed earlier.

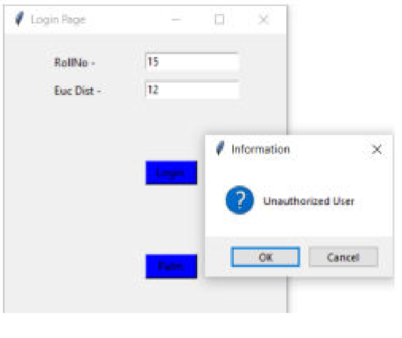

Figure V.4. Unauthorized user (Sample image representing unauthorized user)

IV. DISCUSSION

1. Research on Palm Vein Recognition Algorithm Based on Improved Convolutional Neural Network is proposed by Bo Sun, et al.[1] When collecting palm vein images, it is easy to be affected by external factors such as light source and placement angle, which result in poor recognition accuracy. A new method, which involves a new method of region of interest segmentation and an improved palm recognition method of VGG16 deep convolutional neural network, was proposed to promote the recognition accuracy and be well adapted to the actual application scenarios. Firstly, the original palm vein image is obtained through profile original image, positioning key point of original image, and extract region of interest image. Afterwards, the adaptive histogram equalization technique and Gaussian Filters are utilized to improve image quality. Secondly, for palm vein image recognition application scenarios, the output of the convolutional layer of the VGG-16 convolutional neural network is standardized in batches, and the attention mechanism is introduced to optimize the VGG-16 neural network. Thirdly, data enhancement was performed on the public PolyU multispectral palm vein data set, and then a large number of experiments were carried out, and the best recognition rate was 99.57%.

2. Hoang Thien Van, et'al [2]proposed Palm Vein Recognition Using Enhanced Symmetry Local Binary Pattern and SIFT Features. The palm vein feature extraction method for contactless palm vein recognition is based on combining enhanced center-symmetric local binary pattern (ECS-LBP) with SIFT, called EL-SIFT. The proposed method includes two steps in which step 1 is applying ECS-LBP to detect stable and clear palm-vein lines and step 2 is extracting SIFT feature on palm vein lines image. The experimental results on the public contactless palm vein databases (CASIA Multispectral Palm vein Image Database V1.0) show that our proposed method is accurate and robust for palm vein recognition in comparison with other approaches in the literature.

3. Palm Vein Recognition Using Convolution Neural Network Based on Feature Fusion with HOG Feature is proposed by Xiaolin

Ma, et'al.[3] Palm vein recognition has become a popular research in biometric recognition due to its unforgeable characteristics. Aiming at the complex design of palm vein recognition based on traditional feature engineering methods, this paper proposes to use the deep features of convolutional neural networks fused with hog features to identify palm vein. Experiments show that this method has achieved both higher speed and accuracy on two different databases, which achieves the recognition accuracy of 99.25% on CASIA and 99.90% on PolyU respectively.

4. Competitive Coding Scheme based on 2D Log-Gabor filter for Palm Vein Recognition is proposed by Larbi Boubchir, et'al. [4]The proposed method consists of two major steps in which the first step is inspired by the bitwise competitive coding, the feature extraction employs 2D log Gabor filtering where the final feature map is composed by the winning codes of the lowest filters' bank response and second step is the matching process which uses the Jaccard distance as a metric to capture efficiently the similarities between the feature maps and allowing to make a decision. MS-Polyu databases have shown that the proposed method yields significant performance gains compared to existing state-of-the-art methods.

5. Lightweight and Privacy-Preserving Template Generation for Palm-Vein-Based Human Recognition by Fawad Ahmed, et al[5] is a wave atom transforms (WAT)-based palm-vein recognition scheme. The scheme computes, maintains, and matches palm-vein templates with less 5 computational complexity and less storage requirements under a secure and privacy-preserving environment. First, we extract palm-vein traits in the WAT domain, which offers parser expansion and better capability to extract texture features. Then, the randomization and quantization are applied to the extracted features to generate a compact, privacy-preserving palm-vein template. The extensive experimental results demonstrate comparable matching accuracy of the proposed scheme with a minimum template size and computational time of 280 bytes and 0.43 s, respectively.

6. An Automated Biometric Identification System Using CNN-Based Palm Vein Recognition proposed by Sin-ye Jhong, et'al[6] is palm vein recognition that provides accurate results and has received considerable attention. They developed a novel high-performance and noncontact palm vein recognition system by using high-performance adaptive background filtering to obtain palm vein images of the region of interest. Then used a modified convolutional neural network to determine the best recognition model through training and testing. Finally, the developed system was implemented on the low-level embedded Raspberry Pi platform with cloud computing technology. The results showed that the system can achieve an accuracy of 96.54%.

7. Fuzzy Rider Optimization Algorithm for vein-based biometric recognition system proposed by Dipti Verma, et'al[13] is the model for vein-based biometric recognition using the rider- based score level fusion method. The developed method includes four steps, which are pre-processing, vein extraction, feature extraction and biometric recognition. The first step is to input the training images, like finger, hand, and palm into a pre-processing step. In the pre-processing level, noises are removed from the input image and the Region of Interest (ROI) extraction is also executed in the pre-processing module based on the neighborhood search method. Entropy-based Euclidean 7 Distance (EED) is developed for score level fusion. At last, the biometric identification is carried out based on the proposed Fuzzy Rider Optimization Algorithm (Fuzzy ROA). The performance metrics, such as False Rejection Ratio (FRR), False Acceptance Ratio (FAR) and accuracy are analyzed, and then compared with other methods. The evaluation of the developed method attains the maximum accuracy of 90.19%, minimum FAR and FRR of 10.09% and 0.87% respectively.

V . CONCLUSION

Numerous studies have utilized LBP for vein image recognition due to its higher texture representation ability. However, most studies operate on the entire image, while the fact remains that each region has a unique contribution to biometric identification via the LBP algorithm. We proposed a matching approach in terms of partitioning of the LBP histogram within the vein and its neighborhood, and comparative experiments demonstrated that our proposed method is able to highlight the texture in palm vein images and achieve better recognition performance. To improve the matching accuracy of the to-be-matched regions from contactless palm vein images, k-means segmentation was utilized for texture extraction of palm vein ROI. To demonstrate the effectiveness of our proposed method, the CASIA Multispectral Palmprint Image Database, including 600 images from 100 individuals, was adopted for testing and an accuracy greater than 90% has been achieved.

Moreover, this type of authentication can be applicable in different security systems such as physical admission into secured areas, login control, ID verification in health care services, electronic record management, secure ATM accessibilities in financial services etc. Palm vein authentication sensors have been installed in many access control systems. They are used to control entry and exit for rooms or buildings. Palm vein authentication is well suited to access control systems because of their contactless nature, simple and easy to use and difficult to counterfeit. Palm vein authentication in financial services is applied as follows. A user's palm vein pattern is registered at a bank counter and stored on a smart card. This has the advantage of allowing users to carry their own palm vein pattern with them. In the verification process for ATM transactions, the palm vein pattern of the user is captured by a palm vein authentication sensor on the ATM. The capture palm vein pattern is transferred to the user's smart card and compared to the template stored in the smart card. Finally, a matching result score is transmitted back from the smart card, keeping the palm vein template within the smart card. Also used in healthcare, airport security, government agencies, banks, confidential places, etc.

VI. REFERENCES

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