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LBP-Based Contactless Palm Vein Authentication

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1. 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. 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.

2. INTRODUCTION

Formerly, the only methods for granting someone access to anything were passwords and swiping cards. Traditional authentication methods like passwords, swipe cards, and identifying numbers have mostly failed to fulfil the demands of convenience, dependability, and security as financial activity and security awareness have increased. We currently utilise biometric identification because of their limitations. Human features are used in biometric identification to validate an individual. Fingerprint, iris, face, retina, hand geometry, voice, DNA, and ear biometrics are only a few examples of the biometric identification methods. Facial recognition is one of them that is frequently used to detect people with unblemished backgrounds. But when the face is covered in facial hair, other body parts, goggles, scars, etc., it becomes an issue. Identification methods that involve palmprints and fingerprints are also quite popular. Nevertheless, they must make touch with the sensor, which is thought to be unhygienic and can occasionally produce incorrect findings due to previously recorded impressions on the sensor. Moreover, environmental factors like dust, moisture, water, grease, etc. have an impact on accuracy. While iris recognition is incredibly secure, the cost of the scanner and the installation are intolerable. Also, each time we attempt to approve, our eyes are exposed to infrared rays for more than 10 seconds, which is very bad for our eyes. In addition to this, extrinsic biometric qualities like handwriting or signatures may be faked, which compromises security and privacy, whereas intrinsic biometric traits like DNA and palm vein patterns are challenging to fabricate since they are found deep inside the body. Of all of them, Palm Vein patterns are more effective and simpler to learn.

The veins on the palm have a complicated, network-like structure. When there is natural lightning, they are present beneath the skin but are undetectable to the naked sight. These can only be seen when the scanner's infrared light is turned on. A palm vein scanner maps the distinct vein anatomy of the palm by employing infrared light to collect over 5 million data points. For each and every person, the vein patterns are unique. Even identical twins' hand vein patterns differ. Certain characteristics of palm veins provide great defence against external injury, spoofing, etc. This task is primarily divided into two parts, with training phase coming first and testing phase coming second. Input, feature extraction, and pre-processing make up the training phase.

Pre-processing is done first to the palm print photos. In order to improve analysis and subsequent processing, pre-processing aims to improve the characteristics of the palm picture. K-means is used in the following situations:

It increases accuracy and robustness to remove noise during texture extraction. We shall discover the Area of Interest (ROI) later, which is crucial to preserving tolerance. Finally, using extracted palm veins as a baseline for comparison, a Mutual Foreground based LBP matching approach is used to find commonalities. Each pixel's neighbouring pixels are compared to get relative values for each pixel in LBP. In order to discover the best matching area (BMR), we also used the matched pixel ratio (MPR), which can help LBP matching perform even better. Thirdly, the identification performance was further enhanced by fusing the matching score achieved during the search for the BMR with the outcomes of the LBP matching. Finally, a better Chi-square distance is suggested to boost computing efficiency. The individual is then verified as being who they claim to be and is shown if they have permission or not.

3. LITERATURE SURVEY

1. Research on Palm Vein Recognition Algorithm Based on Improved Convolutional Neural Network is proposed by Bo Sun, et al. 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 involve 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 proposed Palm Vein Recognition Using Enhanced Symmetry Local Binary Pattern and SIFT Features. The palm vein feature extraction method for contactless palm vein recognition based on combining enhanced centre-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 Multi-spectral Palm vein Image Database V1.0) show that our proposed method is accurate and robust for palm vein recognition in comparing 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. Palm vein recognition has become 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 network 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. 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 database have shown that the proposed method yields a significant performance gain 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 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 traitsin the WAT domain, which offerssparser 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 is palm vein recognition 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. Segmentation of Palm Vein Images Using U-Net by Waleed H. Abdulla, et'al 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 region of interests. Morphological operations were applied to obtain ground truth mask images. The mask images were then used to train a modified U-Net in which 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.

8. Sin Choun Soh, et'al 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 colours 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 MRDCT

and FPDCT was able to improve recognition rate compared to using a single image. The equal error rate improvement is also significant, falling to 9% in 700nm image, 7% in 850nm image and 6% in 940nm image.

9. Vein Biometric Recognition on a Smartphone by Raul Garcia-martin, et'al is a novel wrist vascular biometric recognition is designed, implemented, and tested on the Xiaomi Pocophone 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 PISCVBR, 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.

10. Identification of individuals using palm vein classification by Hussein Kannan, et al is a palm identification using Gabor filter. method processes images using Gaussian filter and histogram equalization methods. The features are then extracted using bank of Gabor filters. They apply L2- max norm of superposition into output of Gabor filter to reduce the dimension of the features vector. Finally support vector machine (SVM) and Nearest Neighbours classifiers are used for palm vein verification. 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 is used. The experimental results confirm that the introduced approach is efficient compared to the traditional methods.

4. MOTIVATION

In today's world security is one of the major issues. Many technologies are being developed to enhance the security. The most common way of authentication is by using biometrics. There are different ways of identifying a person like finger print authentication, iris recognition, face recognition etc. New research in biometrics stated that palm vein recognition has gained the attention of people because of its security, accuracy, reliability.

Security: Palm vein scan is more secure than other biometrics because it is never exposed. For example, if a person uses facial recognition for authentication purposes, then their password is their face which is literally exposed everywhere they go. Hence there are more chances for being stolen and duplicated. But with palm vein, since your biometric code is concealed inside your hand, it is very difficult for a thief to steal this pattern and forge or duplicate it.

Accuracy: As comparison to the finger or eye, a person's palm has a bigger surface area. Hence, the palm vein scanner can record a greater volume of data. As a result, it outperforms other biometrics in terms of accuracy. Palm vein has the lowest false acceptance rate (FAR) and false rejection rate (FRR) of any other biometric. It will always function as intended; it is very rare that it would mistakenly refuse access to legitimate users or permit access to illegitimate ones. Facial recognition, for instance, is often far less reliable than other biometrics.

Reliability: As everyone's palm vein pattern is very consistent throughout life, it is quite unlikely that a registered user will ever need to re-register. By comparing a person's old photograph with contemporary image, for instance, we might see significant changes in the face. So, the person needs to be enrolled once more.

5. DESIGN AND TECHNICAL DESCRIPTION

The dataset is divided into two phases. They are training phase and 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 authorised or not.

For implementing our work, we are using python programming language along with MySQL database to store the information. Python is free and open-source programming language. This makes it easy to use and distribute Python is a general-purpose, interactive, object-oriented, and high-level programming language that may be interpreted. You do not need to build Python before running a programme since the interpreter processes it at run time. Python supports the object-oriented methodology of enclosing code in objects.

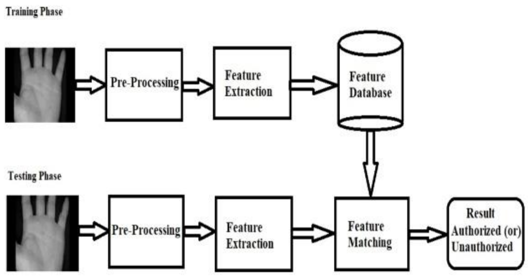
It can be used as scripting language. We can also access databases using Python. The standard library of python is huge we can find almost all the functions needed for our task. It is also portable that means write once and run it anywhere.

It is used in different applications like GUI based desktop applications, graphic design, image processing, games and scientific computational applications, web framework applications, enterprise and business applications, operating systems, database access and software development applications. Here we are using Python IDLE (version 3.7.6).

For the purpose of storing and maintaining the details of the users we are using MySQL database.

It is a relational database management system based on SQL (Structured Query Language.). It is one of the most popular languages for accessing and managing the records in a table. MySQL is 13 open source and free software under GNU

License. It is easy to use. It supports multithreading that makes it scalable.



It is considered as the very fast database languages. It also supports large number of embedded applications. It provides high performance and high productivity.

6. PROBLEM METHODOLOGY AND SOLUTION

Providing Input: The first and the fore most step in any of the model 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 palm print image database, containing 600 images collected from 100 individuals is used as the input dataset.

Pre-Processing: 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 crucial that we pre-process our data before incorporating it into our model. Image processing is a technique for applying various procedures to a picture in order to improve it or extract some relevant information from it. It is a sort of processing where the input is an image and the output might be another picture or attributes or qualities related to that image. Computer-based digital picture alteration is made possible with the use of digital image processing tools. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

The purpose of pre-processing is to increase certain picture characteristics necessary for additional pre-processing or to improve the image data by suppressing unintentional distortions. The first step is to convert the RGB image into grayscale image because grayscale image is a layer image from 0 to 255 whereas the RGB have three different layers. So that it is a reason we prefer grayscale image instead of RGB. The next step is to separate the background.

By masked the foreground, the backdrop is divided. By creating a foreground mask, the background subtraction approach allows us to distinguish between our foreground objects and the backdrop. The next step is to extract ROI. The ROI extraction is a major task in the palm vein identification. The ROI extraction refers to carrying out a series of adjustments and key points location for palm vein images, then the effective area of centre 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 image including rich information of palm vein is extracted, 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.

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, etc... each having different intensities... with the help of K means algorithm we will make them into clusters where k indicates the no. 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 is 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 kind of pixels. This process is repeated for all the pixels of the image. In 17 the next iteration new centroids are chosen and same steps are repeated as earlier. After completion of all the iterations we will get a clustered image which categorises 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 same distance value for more than one centroid, etc., The loss value decrease with increase in number of iterations.

Feature Matching:

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. Neighbours: 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.

Let's say we have a grayscale picture of a palm. A picture may be divided into 3x3 pixel windows. As a 3x3 matrix holding the intensity of each pixel, it may also be shown (0-255). Next, it is necessary to utilise the threshold value that is the matrix's centre value. The new values from the eight neighbours will be defined using this value. We establish a new binary value for each neighbour of the threshold value. We set the threshold at 1, with 0 denoting values below it, and 1 denoting value equal to or higher than it. Now, the matrix will only have binary values (with the centre value ignored). Line by line, starting with position 18 of the matrix, we must concatenate each binary value from each position into a new binary value. This binary value is then converted to a decimal number and put to the matrix's centre value, which is really a pixel from the original picture. We have a new image that more accurately captures the qualities of the original image after this process (LBP technique).

7. CONCLUSION AND FUTURE SCOPE

Numerous studies have utilized LBP for vein image recognition due to its higher texture representation ability. However, most studies operated 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 neighbourhood, 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 Multi-Spectral Palm Print Image Database, including 600 images from 100 individuals, was adopted for testing and an accuracy greater than 90% has achieved.

Moreover, this type of authentication can be applicable in different security systems such as physical admission into secured areas, log in control, ID verification in health care services, electronic record management, secure ATM accessibilities in financial services etc. Several access control systems now feature sensors for palm vein authentication. They are used to regulate access and exit for buildings or rooms. Since palm vein authentication is contactless, straightforward, and challenging to forge, it is a good fit for access control systems.

Palm vein authentication is 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.

8. REFERENCES

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