Touchless Palmprint Recognition System using Image Processing

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Abstract :*A biometric system is a system that uses biometric data and mathematical algorithms to recognize a certain feature of an individual. In recent years from various biometric identifiers palmprint has been widely used for identifying people. Palmprint is popular nowadays because of its ridges is big compared to the fingerprint. The use of palmprints has reawakened attention due to recent developments in image capabilities on mobile and wearable consumer devices. Specially in this COVID19 situation and also because of privacy and sanitation it is good and more secure to use touchless system rather than a touch-based system. So, a touchless system prevents society from using fake biometrics. In this paper we design and develop a touchless palmprint recognition system to verify people. In proposed system people can verify themselves more accurately and quickly. This system contains two modules such as Enrollment module and Identification module. And Enrollment module is mainly used to store the palmprint details in the database and from the Identification module system verify people. Here we use Gabor filter as the feature extraction tool and used IITD touchless palmprint dataset.*

Keywords: *Palm Print Recognition, Touchless Palm Print Recognition Systems, Feature extraction, Gabor Filter.*

1. Introduction

The field of biometrics is used to analyze the uniqueness of biological and physiological characteristics with the aim of confirming a person's identity. To accomplish this requirement, there are a lot of biometrics systems have been designed and used in all over the world.

A biometric system is a system that recognize a certain characteristic of an individual using mathematical algorithms and biometric data. These systems offer numerous numbers of benefits. Since biometric data is non-transferable, unforgettable, distinct, and unique compared to other traditional identification methods such as pin numbers and passwords. Due to these advantages, biometric authentication methods can be trusted. Generally, we use most common biometric identifiers such as fingerprints, facial, voice, iris, and palm to recognize and confirm person's identity. Among them, palmprint can be identified as a special biometric type when compare with others due to its promising features.

2. The Research Problem and Solutions

In these days traditional identification techniques are not suitable for identification systems as they are less secure. Users no longer receive the user security or protection they require from passwords. The capacity of a machine to crack passwords increases with the power of computers. Moreover, Cybercriminals might also purchase them to use in fraud and unlawful access with every new cyberattack. Traditional authentication techniques like usernames and passwords, pin numbers, tokens cannot be trusted to confirm user identification because accounts can be quickly accessed with leaked information. This poses a serious traditional security threat to the information.

When comparing with traditional authentication systems, biometric techniques give more benefits. They are quicker and more practical for users, reduces the friction caused by conventional security techniques and, they have strong authentication since their characteristics re distinct. Also because of public demand for privacy and sanitation everyone prefer touchless system compared to a touch-based one. Specially during this covid19 situation people avoid the touch-based systems. There are many advantages of using touchless approaches such as, easy maintenance, low resolution imaging, stable structural feature, low-cost hardware, fast feature extraction, high verification accuracy, easy availability, and high user acceptability. In public safety, banking, and other systems, biometric applications have played an essential role.

Accordingly, palmprint is discriminative and robust, which can be easily verify with compared to other hand features (2). In addition, it has a higher anti- spoofing potential than faces or fingerprints that helps to leave traces on a variety of smooth surfaces. Not only that but also, palmprint contains more information than fingerprints as it has many lines. Mainly, there are three types of lines that are named as principal lines, wrinkles, and ridges. The significance of these lines is that these lines are used to extract features of the palmprint.

In this proposed system we used raspberry pi camera module for image capturing and Gabor filter as the feature extraction tool. And for the database it used MySQL. The experiment carried out using Python. For the developing part it used IIT Delhi Touchless Palm- print Dataset.

This article does a deep dive into the developed Touchless Palmprint Recognition System. It has been divided into several sections that will touch in order, the problem addressed by the system, the proposed solution, the existing systems related to touchless palmprint recognition system along with their pros and cons, the design of the Touchless Palmprint Recognition System, methodology and details on the system in action. The article will wrap up with its conclusions and references.

3. Related Works

Satya Bhushan Verma and Saravanan Chandran [1] proposed a Touchless Region based Palmprint Verification System. The palmprint was verified using a Gabor filter and a local binary pattern in this paper. In this paper they used IITD and CASIA touchless palmprint databases. In this study, the Chi-square distance, Manhattan distance, and Bhattacharyya distance are used to calculate the distance between two histograms during the verification phase. The proposed approach for verification was evaluated using FAR (False Acceptance Rate), FRR (False Rejection Rate), TSR (Total Success Rate), and EER (Equal Error Rate). The proposed model had the highest FAR=1.5 percent, FRR=1.5 percent, TSR=99.25 percent, and EER=0.75 percent for the Rotation Invariant Uniform Local Binary Pattern using Bhattacharyya distance parameter, and the highest FAR=1.5 percent, FRR=2.5 percent, TSR=99.00 percent, and EER=1.00 percent for the Rotation Invariant Uniform Local Binary Pattern at Chi-squash. Palmprint verification takes 0.88 seconds using the proposed method.

Haryati Jaafar, Salwani Ibrahim, and Dzati Athiar Ramli [2] proposed a Robust and Fast Computation Touchless Palm Print Recognition System Using LHEAT and the IFkNCN Classifier. This work focuses on low-quality palm print picture. The image was segmented during preprocessing to get the ROI. Hand tracking and ROI segmentation are terms used to describe this technique. After that, the image was enhanced using the LHEAT approach. To extract the picture data and minimize the dimensionality of the input data, the principle analysis component (PCA) was used. The classification accuracy was greater than 90% with the LHEAT methodology. Furthermore, the CA attained by the IFkNCN approach was increased to more than 90% for both clean and corrupted pictures, with a processing time of less than 120 milliseconds.

Wai Kin Kong, David Zhang and Wenxin Li [3] proposed a Palmprint Feature Extraction Using 2-D Gabor Filters. This study treats the palmprint as a texture and uses texture-based feature extraction algorithms to authenticate palmprints. To retrieve textural information, a 2-D Gabor filter is utilized, and the hamming distance of two palmprint pictures is compared. The ROI was extracted using a coordinate system based on the limits of fingers. They also used a 2-D Gabor filter to extract textured features and match distances. After the testing, they discovered that the 11th filter is the most accurate of the 12 filters. Their matching approach involves translation and rotational invariance, which is combined with the effects of preprocessing and rotated preprocessed images.

Nageshkumar.M, Mahesh.PK and M.N. Shanmukha Swamy [4] proposed a multimodal biometric system by the combination of face image and palmprint. This work introduces a novel method based on PCA called canonical form, which improves performance and accuracy for both features (face & palmprint). Euclidean distance was used to obtain the matching score for each trait. The metaclassifier and multimodal levels of the multimodal system have been built. Multiple algorithms are integrated to produce superior results at the multi-classifier level. Individual systems were originally created and tested for FAR, FRR, and accuracy in an experimental setting. The system's overall accuracy is over 97 percent, with FAR and FRR of 2.4 percent and 0.8 percent, respectively.

Slobodan Ribaric and Marija Marcetic [5] proposed an approach based on Gabor filter for color palmprint images. A bank of Gabor filters extracts the features from the palmprint region, which is represented by three principal spectral components: R, G, and B. A generalized Hamming distance is used to match palmprints. For fusion of color palmprint photos, they get a recognition accuracy of 98.710.37, while the best identification accuracy for a grey palmprint image is 98.31 0.52 for the same database.

A. H. M. Al-Helali, W. A. Mahmmoud, and H. A. Ali [6] proposed a fast personal palmprint authentication based on 3-D multi wavelet transformation. The use of a 3-D discrete multiwavelet Transform as a feature extractor and a probabilistic artificial neural network (PNN) as a classifier is presented in this paper as an innovative and quick palmprint authentication technique. They tested and evaluated their proposed method upon 240 palmprint images. The proposed technique performed well. It concurrently achieved a greater real acceptance rate and a lower false acceptance rate.

Saravanan Chandran and Satya Bhushan Verm [7] proposed a Touchless Palmprint Verification using Shock Filter, SIFT, I-RANSAC, and LPD. The IITD palmprint database and the CASIA palmprint database are used in the experiment. The SIFT matching score is obtained after refining and compared to the threshold value. If the matching score above the threshold, the palmprints are regarded to be from the same hand; otherwise, they are from distinct hands. The findings of the experiment reveal that the proposed unique method matches the palmprint with 100% accuracy and in a short amount of time.

M. I. Ahmad, M. Z. Ilyas, R. Ngadiran, Mohd Nazrin, and S. N. Yaakob [8] proposed Palmprint recognition using local and global features. The proposed approach is put to the test with the PolyU dataset. This research proposes a palmprint identification system that combines data from global and local feature extraction techniques. In terms of recognition and verification rates, the experimental findings employing PolyU datasets show improved performance. The proposed method has the best performance, with 97 percent recognition rates and 98 percent verification rates.

Dewi Yanti Liliana and Eries Tri Utaminingsih [9] proposed a biometric palm recognition system combining palm print and hand geometry. First, they applied preprocessing then they extracted two features one for palmprint and another one for hand geometry. After extracting features from hand geometry and palmprint, they matched with the database by test feature. They tested the model with 100 samples by using three methods, using a) palmprint, b) hand geometry and c) combination of palmprint and the hand geometry. They achieved higher accuracy rate 89% by the combination of palmprint and the hand geometry compared to others.

Hao Li, Zhenhua Guo, Shouyu Ma and Nan Luo [10] proposed A New Touchless Palmprint Location Method Based on Contour Centroid. The distance between corner points and contour centroid was used in this paper to suggest a new method for finding the centre block of a palmprint image. This technology is made up of an unique touchless palmprint image collection device and an efficient palmprint locating algorithm. A ring source, two CCD cameras (one for near infrared, the other for visible), a frame grabber, and an A/D (analogue-to-digital) converter were incorporated in the touchless palmprint capturing device. The proposed approach may operate at a 96.6 percent genuine acceptance rate, while the false acceptance rate is 3.5747 percent. And it can tolerate the rotation of palmprint image in plane surface.

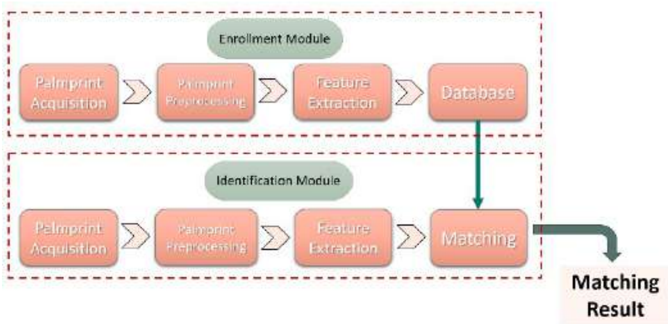
Paper no. & Year	System name	Palmprint dataset	Feature extraction	Used tools (other)	Features
01 (2017)	“Touchless Region based Palmprint Verification	IITD and CASIA	• Gabor filter and Local binary pattern	• Bhattacharyya distance • Chi-square	• Fast identification

02 (2015)	"Robust and Fast Computation Touchless Palm Print Recognition System Using LHEAT and the IFkNCN Classifier"	Database contains 2400 color images	• Principle analysis component (PCA)	• Canny edge detection algorithm • LHEAT • IFkNCN classifier	• Robust and Fast Computation • The device is cost-effective • Does not require expensive hardware • Much faster compared with previous techniques, such as LHE and LAT. • Works well in noisy environments.
03 (2003)	"Palmprint Feature Extraction Using 2-D Gabor Filters"	a palmprint database contains 4,647 palmprint images	• 2-D Gabor filter	• hamming distance	• Used low-resolution palmprint images
04 (2009)	"Multimodal biometric system by the combination of face image and palmprint"	a data set including 720 pairs	• canonical form based on PCA	• Euclidean distance	• Better recognition performance • Accuracy of more than 98%.
05 (2012)	"Approach based on Gabor filter for color palmprint images"	a database consisting of 4647 palmprint images	• Gabor filters	• Fusion at the matching-score level • Hamming distance	• achieved a slightly better performance in comparison with the grey-scale system.
06 (2012)	"Fast personal palmprint authentication based on 3-D multi wavelet transformation"	dataset of 240 samples of palmprint data	• 3-D discrete multiwavelet Transform	• probabilistic artificial neural network (PNN)	• Has a novel and fast palmprint • authentication technique • A higher genuine acceptance rate and a lower false acceptance rate simultaneously
07 (2015)	"Touchless Palmprint Verification using Shock Filter, SIFT, I-RANSAC, and LPD"	IITD and CASIA	• SIFT	• Shock filter • RANSAC algorithm • LPD algorithm	• shows that the proposed novel method matches the palmprint 100% accuracy and in short time.
08 (2014)	"Palmprint recognition using local and global features"	PolyU	• discrete cosine transform(DCT) • LDA	• Fusion at the matching-score level •	• able to increase discrimination power and preserve low frequency coefficients
09 (2012)	"Biometric palm recognition system combining palm print and hand geometry"	dataset of 200 samples of palmprint data	• block-based line detection	• Dynamic Time Warping (DTW)	• highest accuracy rate compared to both of single feature palm print method or single feature hand geometry method.
10 (2011)	"New Touchless Palmprint Location Method Based on Contour Centroid"	database containing palmprint images from 116 different people	• corner point extraction		• Achieve a faster and more stable location on palmprint image.

					• Can tolerate the rotation of palmprint image in plane surface.

(Table 1: summary of techniques and tools that used in reviewed papers)

4. System Design and Methodology



(Figure 1: Design of the system)

The design of the novel Touchless Palmprint Recognition System mainly contains two modules such as the enrollment module and the identification module. In the enrollment module there are four sub modules as image capturing module, preprocessing module, feature extraction module and storing module or the database. Similarly, in the identification module, there are four sub modules as image capturing module, preprocessing module, feature extraction module and palmprint matching module. A brief description of each module is given below.

a. Enrollment Module

The main task of this enrollment module is, taking the palmprint images of the users and save them in a database. Here first, we capture the palmprint image and preprocess the image. Then extract features by using a filter and store the feature extracted palmprint image in the database. There are 4 main sub modules in Enrollment Module.

i. Palmprint Capturing module
ii. Image preprocessing module
iii. Feature extracting module
iv. Storing module

b. Identification Module

The main task of this Identification module is, find if there is a matching palmprint image in the database to the image just captured. Here first, we capture the palmprint image and preprocess the image. Then extract features of the preprocessed image and compare it with the palmprint images in the database already. Then if it found a similar image, it displays the person is verified and if it didn't find a similar image, it displays the person is not verified. There are 4 main sub modules in Identification module.

a) Palmprint Capturing module
b) Image preprocessing module
c) Feature extracting module
d) Image comparing/matching module

a) Palmprint capture

In this touchless palmprint recognition system, it designed a model to capture the palmprint. Here we take the image from a Raspberry Pi camera module.

(Figure 2: Original Palmprint Image)

b) Image Preprocess

In this Image preprocessing step, we mainly obtain the part (sub palmprint image) that is unique in palmprint. Then we eliminate the variation happens to the image due to rotation and translation. Here we crop the image and keep the part that is including principal lines, wrinkles, minutiae points, singular points, and texture. And convert the image into grayscale. Then increase the contrast and the sharpness of the image. This proposed palmprint recognition system used python for this image preprocessing part. The main purpose of this preprocessing step is to extract the certain region form the palm-print which includes principal lines, ridges, and wrinkles.

(Figure 3: Preprocessed Palmprint Image)

c) Feature Extraction

After passing the data through preprocessing step, it needs to extract the features that is unique in the palmprint image. Here it used Gabor filter as the feature extraction technique. Gabor-based approach is widely used for the feature extraction in biometric applications, such as iris, face, fingerprint and palmprint recognition. It is a powerful tool in the fields of computer vision and pattern recognition.

It has several benefits, including rotation, translation, and lighting, all of which are enhanced by capturing the device and palm structure. Because of the larger number of degrees of freedom, the Gabor filter allows for more flexibility in the determination of function form.

$$G(x, y, \theta, u, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} e^{2\pi i(ux\cos\theta + uy\sin\theta)}$$

$i = \sqrt{-1}$

u = the frequency of the sinusoidal wave

$\theta =$ controls the orientation of the function
$\sigma =$ the standard deviation of the Gaussian envelope.

The σ and u are dependent on the size of the filter with

$\sigma * u = \text{const}$.

d) Database

After the system extract features, the feature extracted image stored in a database. Here the system use MySQL for store the palmprint images. During the development of this research the IIT Delhi Touchless Palm-print Dataset was used, and this database mainly consists of the hand images collected from the students and staff at IIT Delhi, India.

e) Palmprint matching

In here we measure the similarity using a matching score of palm print and hand geometry features between test data and the data stored at the training database. The matching score is obtained using Dynamic Time Wrapping (DTW) distance. The higher matching score, the more similar the data. In advance, features must be normalized and scaled prior to the DTW process. The recognition will undergo the same process; each feature vector in the database is compared with the test data and the highest matching score is recognized as the user's feature.

5. Conclusion and Furtherwork

This paper presents a touchless palmprint recognition system using image processing. Although there are several systems for person recognition, this proposed system will be able to increase the accuracy, privacy, and sanitation for everyone because this is a biometric authentication method, and it is touchless.

Further this system has to test and evaluate in to ensure the development of touchless palm print system is more applicable in real application, experiment in various types of noises needs to be extracted before the feature extraction.

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