FAST AND ACCURACY PALM-PRINT RECOGNITION SYSTEM FOR LOW-QUALITY PATTERNS

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Abstract- Palm-print trait based biometric identification has emerged as a most powerful tool to recognize a person's identity. It is used in commercial and forensic applications. In common, it considers high 400 dpi (Dots per Inch) or more is high resolution and 150 dpi or less is low resolution. Earlier research projects have been showed that high-resolution palm images are capable to extract ridges, singular points and minutia points as features. Low-resolution images have capability to extract principal lines, wrinkles, and texture. Therefore, researches which are based on palm prints primarily focus on high-resolution palm images. Therefore the main purpose of this research was to provide a Fast and Accuracy Palm-print Recognition method for low-quality images using image processing with feature extraction. In this research, the database which was used for this is mainly consisted with the palm images which were collected from students. In feature extraction process, low pass filter was used to remove the noises of images. Elongated and tubular structures were enhanced in the noise removed images to highlight major lines by using Hessian-based multi-scale filtering. Segmentation process in the original image transforms the original image in to a binary image in which ridges area fully colored in one tone and the background in the opposite tone. Threshold binary image was applied to some morphological operations to extracting the better results. The palm-print matching process which is also called as the template matching was mainly based on the normalized cross correlation in Fourier domain (phase correlation). This process was done by pixel-by-pixel basis. Results of this process have shown a higher Genuine Acceptance Rate for lower False Acceptance Rate and False Reject Rate.

Keywords- Low Resolution, Principle Lines, Feature Extraction, Template Matching

I. INTRODUCTION

In the real world, in our day to day life, there are so many incidents which have to be faced to so many difficulties because of the lack of concentration due to the turbulent environment of people. As an example what would be happened when it is found that the door key has lost after coming home finishing the job. It could be annoying and finally, it can destroy your whole plan. In the present day, there is very important and valuable resource to find solutions for all of these problems. What would it be? It is progressive technology. With the technology, it is easy to solve these simple but important problems. So, when finding solutions to the above common problem, a simple thing which we always have can be used as the door key. It can be voice, hands, eyes, iris, and fingerprints or palm prints etc. These simple but important things can be used with the technology to solve problems as well as to increase the efficiency of our day to day life.

The using of biometric characteristics of a person to recognize him or her through the technology have been discussed over many years of time. But still it has not come very common and people do not see those technologies in real life in addition to fantastic films. The reason for this situation could be that people may not be able to bear the high expense for these technologies as the practical use of biometric methods are too expensive and there is a myth that it could not be done in real life and people consider as it is only a matter of future. Face recognition, iris scan, signature scan, keystroke scan, palm print are some popular bio-metric identifiers using in the present world. But these characteristics sometimes cannot be able to identify properly with dependence of low-resolution images, form of hair, facial expressions, sometimes it requires special devices and accurate positioning as well as a specialized training. Some technologies may harmful to the people's health. But this palm printing method has many unique advantages when comparing with other methods of biometrics.

- Age of the user is a minimum affected factor in palm printing method. But in face recognition method, it is a major factor to be considered.
- Palm prints contain more information than other methods and low-resolution devices can be used for this identification process of those information.
- It is not harmful to the people's health. Therefore many people prefer palm recognition despite iris recognition.

There are mainly two types of palm-print recognition system.

i. High resolution

ii. Low resolution

Human palm has unique distinguishable line patterns which can be used to identify people uniquely. This very large and internal surface of the human hand which is called palm, contains several specific characteristic features as principle lines, wrinkles, creases, and textures. Therefore palm prints are very robust to noise and unique to every individual.

Comparing with other physical characteristics, palm prints contains many useful and unique features. Those are as follows,

- Principle lines- These lines very little over time. Therefore both location and form of principal lines can be used for recognition of individuals.
- Wrinkles- Wrinkles form rich texture in the hand and, are thinner and more irregular in comparison to principal lines.
- Ridges- Ridges are spread all over to the hand and very thin. It needs high resolution to detect them.
- Delta points - Delta points are the center of the delta-like region of the palm print.
- Minutiae point- Minutiae points are the ridge characteristics, ridge ending, and ridge bifurcation.

A novel technique has been proposed by Zia-Uddin to extract principal lines, which is evident and stable features in palm-print images in two phases without using edge detection. In the preprocessing phase, normalization is done to enhance the contrast of the palm image. With the help of smoothing and median filters noise is removed. In last step of the phase, the palm image is converted to negative. Next in extraction phase Top-Hat filter and contrast enhancement are applied respectively on the negative image and noise is removed with connected component labelling after binarization. In this research, they have used IIT Palm-print Database version 1.0. [8]

Pawan Dubey has presented a new palm-print scheme which is called as Sequency code (SeqC). It exploits symmetric Gabor filtered responses at different orientations. Concatenation of the zero crossings of these symmetric and asymmetric Gabor responses is performed, and bit transition among concatenated zero crossings is counted at corresponding locations to compute Sequency plane, Seq. Finally, Seq is encoded into Sequency code bit plane feature SeqC. Because of its simple fusion strategy, the Sequency code requires less computations and time in feature extraction process. Performance of Sequency code is validated by carrying out large number of experiments with three different standard databases which are PolyU 2D, PolyU 2nd version, IITD and Multispectral databases. [7]

Liliana Studied about biometrics of palm for identification system using the physical form of human hands, represented by the image of the palm. The methodology for palm recognition includes 2 parts.

I. Block-based line detection which dealing with palm print feature extraction process.

II. II. Chain code which solved the land geometric feature extraction.

These 2 respective features were combined and it was introduced as Dynamic Time Warping (DTW) method. It can measure the distance between two different features. Then it was proposed that the result can be used for personal identification in authentication systems for information security.[9]

Inspecting the above details and compare with the other biometric techniques, the palm print is the relatively new biometric feature and is regarded as one of the most stable, reliable and unique personal characteristics. So the main purpose of this research project is to provide a Fast and high Accuracy Palm print Recognition system for low-quality palm-print images using below methodology.

II. METHODOLOGY

The block diagram of the proposed method architecture has been shown in following and this method architecture can be divided into three main steps.

1. Image preprocessing
2. Feature extraction
3. Palm-print matching

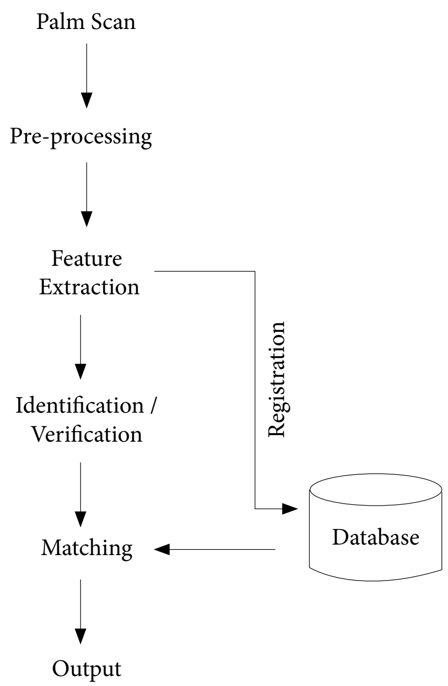

Figure 1. Proposed method architecture

A. Pre-processing, Database, and Region of Interest (ROI) Extraction

Image preprocessing is the first step in pattern recognition. There are two objectives in preprocessing.

I. Obtaining a sub palm-print image for feature extraction.

II. Eliminating the variation happens due to rotation and translation.

This preprocessing block is one of the most critical part of the developed palm-print recognition algorithm, and it is the first block in the developed algorithm as it is the case in many biometric systems. Before feature extraction and coding step, two things must be done.

a. Preprocessing all images in the database.

b. Obtaining the central area of a palm.

The main purpose of this pre-processing step is to extract the certain region form the palm-print which includes principal lines, ridges and wrinkles. Extracting is done by compensating for rotation and translation. The correct extraction of ROI plays a crucial role in improving the performance of the overall palm-print recognition. Indian Institute of Technology, Delhi already provided an ROI image of the database. The IIT Delhi Touchless Palm-print Database version 1.0 has been used during the development of this research and this database mainly consists of the hand images collected from the students and staff at IIT Delhi, India.

B. Feature Extraction

A palm-print can be represented by some line features from low-resolution images. Algorithms such as stack filter are able to extract the principal lines. But, these principal lines are not enough to represent the uniqueness of each individual's palm-print as different people can have same principal lines in their palm-prints. And also some palm-print images do not have clear wrinkles. To extract features from palm-print image several techniques have been implemented such as wavelet. But these methods are unable to detect clear edges and smooth curves which result from the conjunctions of principal lines and wrinkles. In this research project, extract features from low-resolution palm-print images by using IIT Delhi Touchless Palm-print database version 1.0. Following image shows the sample ROI of a palm-print image from the above-mentioned database for extracting principal lines. The software which has been used for this research project was the Matlab.

Noises of the image should be removed before extracting palm lines from ROI image. For this step Wiener 2 lowpass filter is used, shows in figure 3. It is a grayscale image which has been degraded by constant power additive noise. Wiener2 uses a pixel-wise adaptive Wiener method based on statistics estimated from a local neighbourhood of each pixel. This approach produces better results than linear filtering.

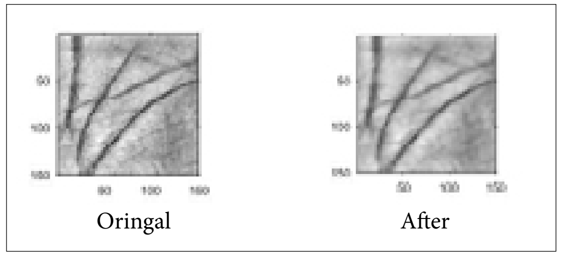

Figure 2. applying the lowpass

After this step, elongated and tubular structures can be enhanced in the noise-removed image for highlights major lines by using Hessian-based multi-scale filtering. The returned image contains maximum response of the filter at a thickness which approximately matches the size of the tubular structure in the image. Figure 4 shows the enhanced version of the noise removed image which highlights threads that are seven pixels thick.

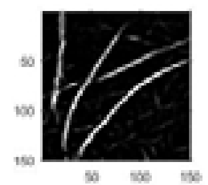

Figure 3. An enhanced version of the image that highlights threads that are seven pixels

Usually, palm-print identification methods rely on grayscale pictures and samples. It is because colour identification is not essential to identify a subject. After completing the segmentation process the original image has to be transformed into a binary image in which ridges area fully colored in one tone and the background in the opposite tone. Image binarization is fundamental to find principal lines or other singularities.

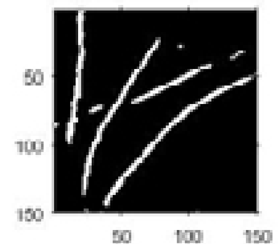

Figure 4. Threshold result

And this image binarization is done in other computer version processes as well as palm-print identification. Image thresholding is ineffective way to partition an image into a foreground and background. It isolates objects of the image by converting grayscale images into binary images. The binary image is specified as a non-sparse, local or numeric array of any dimension. This image thresholding is most effective in images with high levels of contrast. In this threshold image, as shown in figure 4, each pixel represents binary values 0 and 1. Finally, Threshold binary image is applied to some morphological operations for extracting better results.

III. MATCHING PALMPRINTS

After completing this line extraction process, features are extracted for matching. Here, 50 palm print images have been selected randomly from 10 different persons and each person have 5 different palm images. In this palm-print matching step, one palm-print is selected from each person as the template image. This template image is subjected to the principle line extraction process. Then those specific output values are enrolled which were obtained from that template image. Total 10 enrollments are saved for the matching. In this step, the palm-print matching process is based on normalized cross correlation in Fourier domain and it is also known as phase correlation. Here in this context, correlation can be called as template matching and the two variables are the corresponding pixel values in two images, template, and source.

Cross-correlation is a measure of the displacement of one relative to the other. In normalized cross-correlation, two images are used to snapshots of the same scene. Template matching techniques compare portions of images against one another and sample images are used to recognize similar objects in the source image. Template matching is used when the standard deviation of the template image compared to the source image is small. This matching process moves the template image to all possible portions in a larger source image and a numerical index is computed which indicates how well the template matches the image in that position. This matching process is done on a pixel-by-pixel basis.

A. Cross-Correlation Analysis

Cross-correlation is a kind of template matching, between two input signals. It can be done in any number of dimensions. One-dimensional normalized cross-correlation between two input signals can be defined as follows.

$$r_d = \frac{\sum_i [(x[i]-\bar{x}) \cdot (y[i-d]-\bar{y})]}{\sqrt{\sum_i (x[i]-\bar{x})^2}\sqrt{\sum_i (y[i]-\bar{y})^2}}$$

r – a measurement of the size and direction of the direction of the linear relationship between variables x and y. r= +1, if these variables move together, where they both rise at an identical rate. r= 0, if the other variables do not budge. r= -1, if the other variable falls at an identical rate. If r is greater than zero, the correlation is positive and r is less than zero the correlation is negative. The sample non-normalized cross-correlation of two input signals requires that r be computed by a sample-shift (time-shifting) along one of the input signals. For the numerator, this is called a sliding dot product or sliding inner product.

The dot product is given by the following equation.

$$X \cdot Y = \sum_i x_i y_i$$

When equation 1 is computed, for all delays, then the output is twice that of the input. When showing a cross-correlation, usually the pentagon notation can be used.

$$(X \star Y)_d = \sum_i x_i y_{i+d}$$

Where the asterisk indicates the complex conjugate which is a negation of the imaginary part of the number. Input signals should either have the same length or a policy in place to make them the same (perhaps by zero padding or data replication). Following equation can be written if the input signals are real-valued.

$$(x \star y)_d = \sum_{i=-\infty}^{\infty} x_i y_{i+d}$$

Comparing equation 4 with the convolution.

$$x_n * y_n = \sum_{i=-\infty}^{\infty} x_i y_{n-i}$$

Y is time-reversed before shifting by n. In comparison, the correlation has to shift without the time reversal.

B. Fourier Transform Analysis

The Fourier transform is a representation of an image as a sum of complex exponentials of varying magnitudes, frequencies and phases. It plays a critical role in a broad range of image processing applications including enhancement, analysis, restoration, and compression.

If f(m, n) is a function of two discrete spatial variables m and n, then the two-dimensional Fourier transform of f (m, n) is defined by the following relationship.

$$F(w_1,w_2) = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} f(m,n) e^{-iw_1 m} e^{-iw_2 n}$$

F (ω_1, ω_2) – Frequency-domain representation of f (m, n).

It is a complex-valued function that is periodic both in ω_1 and ω_2, with period 2π. Because of the periodicity, usually,

only the range – π ≤ ω1, ω2 ≤ π is displayed. Note that F (0, 0) is the sum of all the values of f (m, n). For this reason, F (0, 0) is often called the constant component or DC component of the Fourier transform. (DC stands for direct current; it is an electrical engineering term that refers to a constant-voltage power source, as opposed to a power source whose voltage varies sinusoidally).

The inverse of a transform is an operation that when performed on a transformed image produces the original image. The inverse two-dimensional Fourier transform is given by

$$f(m,n) = \frac{1}{4\pi^2}\int_{w_1=-\pi}^{\pi}\int_{w_2=-\pi}^{\pi} F(w_1,w_2) e^{-iw_1 m} e^{-iw_2 n} dw_1 dw_2$$

IV. RESULT AND DISCUSSION

In this research project the palm recognition phase has been divided into two stages. The first one is called intra-class comparison. In this study, only one was rejected out of 50 comparisons. This rejection called as false rejections. To check inter-class calculation there are 450 comparisons. Out of these 450 comparisons, there were 44 wrongly accepted results shown. This results called false acceptances.

The performance of biometric security systems can be evaluated from biometric authentication parameters. Those parameters are false accept rate, false reject rate, genuine accept rate, accuracy, half total error rate etc.

False Accept Rate (FAR) is the percentage of faulty/incorrectly recognized users. FAR is a measurement which explains the percentage of faulty recognitions of unauthorized individuals.

$$FAR = \frac{No.of\ false\ acceptance\ found}{Total\ No.of\ Comparisons} \times 100$$

In this study, the calculated FAR is 8.8% according to above experimental results. 44 had been wrongly accepted out of 450 comparisons.

False Reject Rate (FRR) is the measure of the incorrectly rejections of access attempts by authorized individuals, of biometric security system. The FRR is calculated as,

$$FRR = \frac{No.of\ false\ rejection\ found}{Total\ No.of\ Comparisons} \times 100$$

In this study, the calculated FRR 0.5%. One was rejected from 50 comparisons.

Genuine acceptance rate (GAR) is the percentage of genuine users who were accepted by the system and it is defined as,

$$GAR = 1 - FRR$$

In this study, GAR is 99.8%. The GAR should be high.

Also Half Total Error Rate (HTER) is a possible way to measure the performance of the biometric system. It combines both types of system errors of false accept and false reject. It is defined by following formula:

$$HTER = \frac{1}{2}(FAR + FRR)$$

In this study HTER is 4.5%.

Accuracy of the system is the percentage efficiency of the system in terms of its ability of authentication. The accuracy is calculated as,

$$Acuracy = 100 - \frac{FAR + FRR}{2}$$

In the study the calculated accuracy of the system is 95.5%.

Furthermore, the proposed algorithm is implemented using MATLAB R2017a image processing toolbox. The execution time for the feature extraction and coding block is less considerable. Finally, the execution time for the template matching is about 20 milliseconds. Since total verification time does not depend on the number of templates in the database, it can be found by summing up feature extraction and coding block and template matching block. Therefore; the total verification time is calculated to be around 1 second, which is acceptable for a high accuracy palm-print recognition algorithm.

V. CONCLUSION

This research has been conducted in order to develop a Fast and Accuracy Palm Print Recognition System for Low-quality Patterns. Research questions have been answered so that the research objectives are met. It has been identified that most biometric security system studies have been done using finger prints, facial recognition, voice recognition or iris recognition. And there are very fewer number of studies have been identified which has been done using palm prints as the input for the biometric security system. When considering about this proposed algorithm which includes principle line feature with template matching, performances of it is suitable for nowadays commercial applications.

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