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User Authentication Using Palmprint Biometric System

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Abstract - *Biometrics is a field of science and technology whose goal is the identification or verification of a person's identity based on his or her physiological or behavioral characteristics. Thus, biometric answers the question "Who he/she is" rather than "What he/she owns" or "What he/she knows".Commonly used physiological characteristics in biometrics are fingerprint, palmprint, hand geometry, face, iris, retina and ear. Behavioral characteristics include signature, voice, lip movement, gait, gestures and keystroke dynamics. Among these palmprint recognition has received considerable research interest because of many attractive advantages, such as rich texture feature, stable line feature, low-resolution imaging, low-cost capturing devices, and easy self-positioning. Thus palmprint recognition is expected to have a wide range of potential security applications, such as access control, network security, and social security. The goal of the project is to design an efficient biometric system for authentication using palmprint biometric trait.*

Key Words: Authentication, Biometric , Haralick features, Palmprint, Matching

1. INTRODUCTION

Today more and more business activities and work activities are computerized. E-commerce applications such as E-Banking or security applications such as building access demand, fast real time and accurate personal identification which work on approaches such as Traditional knowledge based approach use "something that you know"(such as passwords and PINs) and Token based approach use "something that you have"(such as passports and credit cards) both are tedious, time consuming, ineffective,expensive and hard to remember. These shortcomings have led to Biometric identification and verification systems which can be divided mainly into 3 types : Texture Based, Line Based and Code Based. Texture-based approaches have been studied extensively, which have shown good performance in terms of recognition rates and processing speed. Line based approaches are also important for palmprint recognition since lines are essential and basic features of palmprint. coding based methods are a type of the most promising palmprint recognition methods, because of their small feature size, fast matching speed, and high recognition performance. when line and coding methods are weighed together texture method is best because line based method use only the principle lines of the palm are found difficult to recognize persons[5] and coding based methods are complex in nature whereas texture based methods are known for the unique characteristics of the palm and give the adverse results in contributing to the accuracy rate of the system. Previous researchers have developed effective feature extraction techniques for palms that have provided good results. Very little research has been done in a imposter palmprint those made of plaster and olefin material can be misused by systems and information can be leaked. Hence in this paper the proposed system focuses on Haralick features whose main advantage is aliveness detection[19]. Haralick features are the gray level co-occurence matrices and are 11 in number which are further detailed in the following sections.

There are several challenges in recognition systems beginning from initial module image acquisition to complex environment. These issues can be broadly categorized as follows: separating the hand from an unknown background, extracting the region of interest from the hand consistently in a translation, rotation, and scale invariant fashion and recognizing matches correctly regardless of differences in lighting or blurriness, dust particles In the course of this paper, all these issues will be successfully addressed.

2. SYSTEM OVERVIEW

The proposed model for palmprint biometric system consists of five modules (as shown in figure 1) : Image Acquisition, Preprocessing, Feature Extraction, Template matching and Decision in both training and testing phase. The most important module is the feature extraction which highlights the differentiating elements from one person to another person avoiding illegal and duplicity of palmprint as haralick features are extracted which represent angular second moment, contrast, sum of squares, inverse difference movement, Sum variance, Sum Entropy, Entropy, Difference Variance, Difference entropy, sum average.

Haralick's texture features [28] were calculated using the kharalick() function of the cytometry tool box [29] for Khoros (version 2.1 Pro, Khoral Research, Inc., Albuquerque, NM USA; http://www.khoral.com). The basis for these features is the gray-level co-occurrence matrix **G** in Eq(1). This matrix is square with dimension N_g, where N_g is the number of gray levels in the image. Element [*i*,*j*] of the matrix is generated by counting the number of times a pixel with value *i* is adjacent to a pixel with value *j* and then dividing the entire matrix by the total number of such comparisons made. Each entry is therefore considered to be the probability that a pixel with value *i* will be found adjacent to a pixel of value *j*.correlation variance entropy of palmprint.A brief study of these modules is discussed in further subsections.

$$G=\begin{bmatrix} p(1,1), p(1,2)\cdots\cdots p(1,Ng) \\ . \\ . \\ p(Ng,1), p(Ng,2)\cdots\cdots p(Ng,Ng) \end{bmatrix} \quad Eq(1)$$

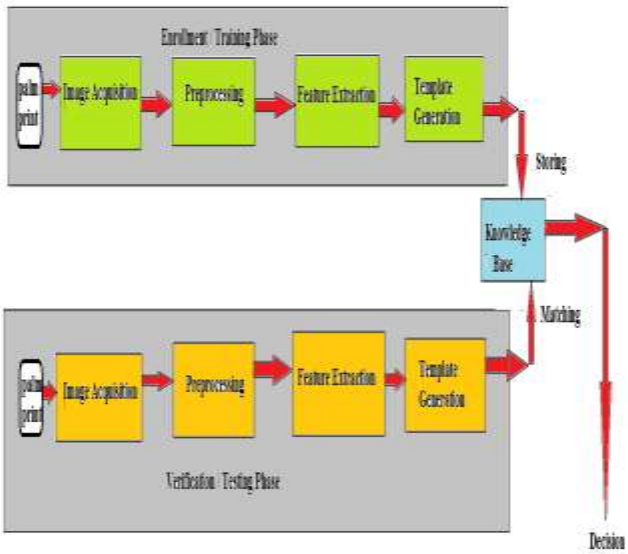

Fig -1: Proposed model

2.1 IMAGE ACQUISITION

Image acquisition means the process of collection of biometric traits, Here we have collected palmprint samples from polyudatabse and Mspalmprint database. It is not compulsory to consider these databases one can choose the images simply clicked by your camera, scanner, hand tracking device or a snap from video. As per our requirement we used these two mentioned databases. In regard to Mspalmprint database(multispectral) the Biometric Research Centre (UGC/CRC) at The Hong Kong Polytechnic University has developed a real time multispectral palmprint capture device which can capture palmprint images under blue, green, red and near-infrared (NIR) illuminations, and has used it to construct a large-scale multispectral palmprint database. Multispectral palmprint images were collected from 250 volunteers, including 195 males and 55 females. The age distribution is from 20 to 60 years old. Each subject was asked to provide 6 images for each palm. In total, this database contains 6,000 images from 500 different palms for one illumination. The second database polyudatabse contains palmprint images from 386 different persons captured with a specialized device using camera because of the number of images it contains is best suitable for our experiments. The samples of both these database are shown in figure 2 and figure 3

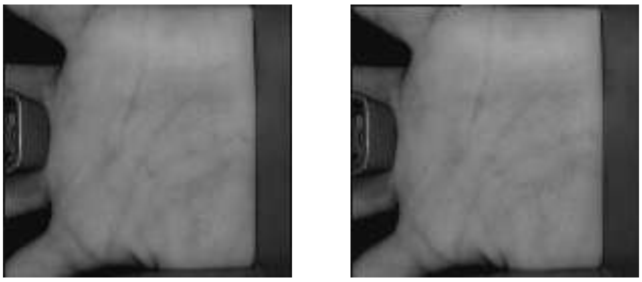

Fig -2: MS palmprint database samples

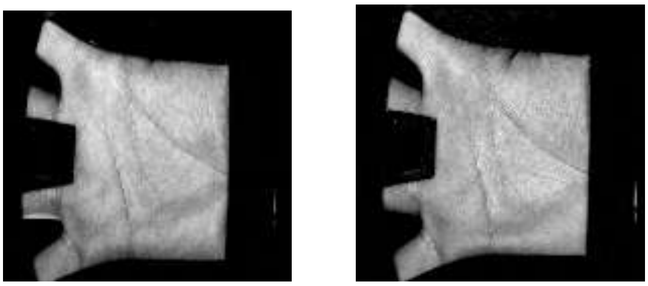

Fig -3: PolyUdatabase samples

2.2 PREPROCESSING

Preprocessing module marks the beginning of the actual project. Preprocessing is defined as the process of enhancement of the palmprint images collected in the image acquisition module by adjusting the contrast and brightness of the image and also removes the dust, noise particles from samples and makes the image look better than earlier original sample. The main necessity of preprocessing is to make things easy in the next module i.e feature extraction which requires grey level co-occurrence matrices to extract harlick features, this conversion is done in the third stage of preprocessing.

The stages in the Preprocessing are as follows:

1. Apply a low pass or high pass filter[14] to the original image use either If you just need a 1-pole low-pass filter, it's

xfilt = filter(a, [1 a-1], x)

where a = T/τ, T = the time between samples, and τ (tau) is the filter time constant.

Here's the corresponding high-pass filter

xfilt = filter([1-a a-1],[1 a-1], x) to reduce the noise in case to remove it completely from the original image and title it as filtered enhanced image.

2. The negative of an image with grey levels in the range

[0, L-1] is obtained by the negative transformation which is given by the expression,

$s = L - 1 - r$

This expression results in reversing of the grey level intensities of the image thereby producing a negative like image. The ouput of this function can be directly mapped into the grey level co-occurrence matrices which act as basic steps for haralick feature extraction consisting values from 0 to L-1.This includes in the second stage of preprocessing as shown in the figure 4

3.Next step is the extraction of ROI(region of interest) as shown in the figure 5 by marking the points near fingers and using axes operations and imcrop function to detatch the ROI.

In other words image preprocessing is the technique of enhancing data images prior to computational processing. Pre-processing is a common name for operations with images at the lowest level of abstraction -- both input and output are intensity images. The process is an improvement of the image that suppresses unwanted distortions or enhances some image features important for further processing. It aims to correct some degradation in the image, the nature of a priori information is important: knowledge about the nature of the degradation; knowledge about the properties of the image acquisition device, and conditions under which the image was obtained. The nature of noise (usually its spectral characteristics) is sometimes known. After the completion of preprocessing module, is followed by feature extraction module.

Fig - 4: Preprocessing: stage: Original image

Fig -4: Preprocessing: stage 1: Filtered enhanced image

Fig- 4: Preprocessing: stage 2: Negated enhanced image

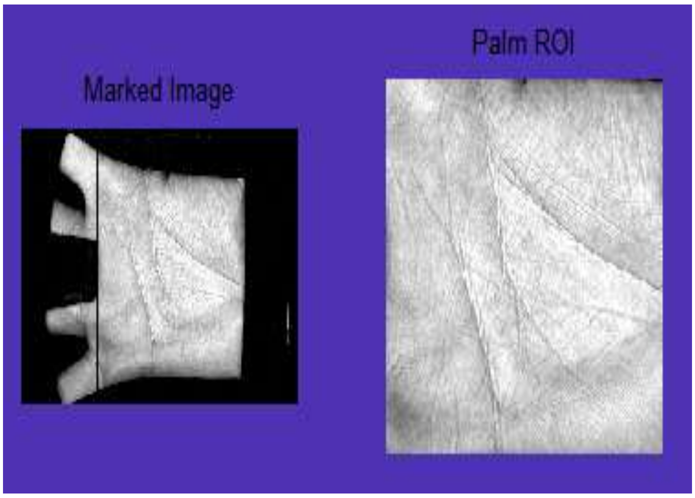

Fig-5: Preprocessing stage 3:Extraction of ROI : 1) Marked image 2) Palm ROI

2.3 FEATURE EXTRACTION

Haralick features mainly concentrate on the “aliveness detection” in the sense it works out on the fake palmprints those made of plaster and olefin material differentiates between them.Thus helps to avoid the unauthorized and illegal use of biometric systems. In this section the haralick features are extracted from the ROI which resulted in the preprocessing module. Haralick features extracted from an image texture are obtained from the grey-level co-occurrence matrices (GLCMs) that contain information about the statistical distribution of grey levels in the analysed image [12], [13]. The co-occurrence matrix P(g, g', δ, Θ), size G x G, where G is a cardinality of a set of quantizied grey-level values LG of an image, contains at the position (g, g'), a number of occurrences of a pair of pixels that are at a distance δ = 1, 2, 3, ... , in the direction Θ = 00, 450, 900, 1350, where one pixel has a grey-level value g ∈ LG, and another pixel has a grey-level value g' ∈ LG. The GLCM has to be normalized in such a way that each element of the matrix is divided by R, where R is the sum of all the elements in the matrix. Based on the normalized GLCM, Haralick has proposed 14 statistical features, among these we concentrate only on the 11 features, that can be calculated for each δ and Θ detailing below:

Notations:

$p(i,j) = (i,j)th$ entry in a normalized gray-tone spatial dependence matrix, $= p(i,j)/R$

$px(i) = ith$ entry in the marginal-probability matrix obtained by summing the rows of $p(i,j) = \sum_{j=1}^{Ng} p(i,j)$

Ng Number of distinct gray levels in the quantized image.

$$py(j) = \sum_{i=1}^{Ng} p(i,j)$$

$$p(x \pm y)[k] = \sum_{i=1}^{Ng} \sum_{j=1}^{Ng} p(i,j)$$

The haralick features are represented as follows

1.Angular second moment

$$f1 = \sum_i \sum_j \{p(i,j)\}^2$$

2.Contrast

$$f2 = \sum_{n=0}^{Ng-1} n^2 \left\{ \sum_{i=1}^{Ng} \sum_{j=1}^{Ng} p(i,j) \right\}$$

3.Correlation

$$f3 = \sum i \sum j(i,j)p(i,j) - \mu_x \mu_y / \sigma_x \sigma_y$$

Where μ_x, μ_y, σ_x and σ_y are means and standard deviations of p_x and p_y

4.Sum of squares : variance

$$f4 = \sum i \sum j(i-\mu)^2 p(i,j)$$

5.Inverse difference moment

$$f5 = \sum_i \sum_j \left(1/1 + (i-j)^2\right) p(i,j)$$

6.sum average

$$f6 = \sum_{i=2}^{2Ng} i p_{x+y}(i)$$

7.sum variance

$$f7 = \sum_{i=2}^{2Ng} (i - f8)^2 p_{x+y}(i)$$

8.sum entropy

$$f8 = -\sum_{i=2}^{2Ng} p_{x+y}(i) \log\{p_{x+y}(i)\}$$

9.Entropy

$$f9 = -\sum_i \sum_j p(i,j) \log(p(i,j))$$

10.Difference variance

$f10 =$ variance of p_{x-y}

11.Difference entropy

$$f11 = -\sum_{i=0}^{Ng-1} p_{x-y} \log\{p_{x-y}(i)\}$$

2.4 MATCHING

The use of probabilistic neural network classifier in the training and testing phase in the matching module is done. A probabilistic neural network (PNN) is predominantly a classifier maps any input pattern to a number of classifications can be forced into a more general function approximator A PNN is an implementation of a statistical algorithm called kernel discriminant analysis in which the operations are organized into a multilayered feed forward network with four layers:

- Input layer
- Pattern layer
- Summation layer
- Output layer

In our system the input layer of PNN compares with the trained samples and in the pattern layer ,the haralick features extracted are dealed with the summation for comparison with the tested samples and output layer identifies as the recognized person which was trained earlier. some of the advantages of PNN are fast training process, orders of magnitude faster than backpropagation an inherently parallel structure guaranteed to converge to an optimal classifier as the size of the representative training set increases, no local minimal issues, training samples can be added or removed without extensive retraining.

3. EXPERIMENTAL RESULTS

In the training phase of our proposed model the extraction of the 11 haralick features for the polyudatabase is obtained in the TABLE 1 prescribed. The table contains individual person's two samples and values of haralick features when considered the same two samples for a single person there is a bit variation in the values but somehow it differs a lot when considered for both different person based on this we differentiate one person from another person.the system is tested for the 100 samples of polyUdatabase.

The features are extracted are explained here angular second moment feature is a measure of the smoothness of the image. and measure of homogeneity of an image. A homogeneous scene will contain only a few gray levels, giving a GLCM with only a few but relatively high values of P(i, j). Thus, the sum of squares will be high.inverse difference moment is also influenced by the homogeneity of the image. Because of the weighting factor it will get small contributions from inhomogeneous areas. Contrast is a measure of the intensity contrast between a pixel and its neighbor over the whole image. correlation Returns a measure of how correlated a pixel is to its neighbor over the whole image. The variance is a parameter describing in part either the actual probability distribution of an observed population of numbers(pixels), or the theoretical probability distribution of a sample (a not-fully-observed population) of numbers(pixels).Correlation is a measure of gray level linear dependence between the pixels at the specified positions relative to each other.and the other feature variance feature puts relatively high weights on the elements that differ from the average value. Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image.

Thus depending upon the varying values of these haralick features our system successfully authenticates and verifies the person's identity with the approximated results mentioned in the next section.

TABLE 1: HARALICK FEATURES EXTRACTED OF DIFFERENT SAMPLES

samples	Person1 sample1	Person1 sample1	Person2 sample1	Person2 Sample2
Angular Second moment	0.18	0.20	0.24	0.23
Contrast	79.85	74.60	72.70	72.67
Correlation	0.20	0.19	0.2	0.19
Sum of squares	197.84	198.49	194.73	194.46
Inverse difference moment	0.49	0.51	0.61	0.55
Sum average	395.69	396.97	389.36	389.29
Sum variance (var.)	395.84	397.14	389.4	389.39
Sum entropy	-0.15	-0.16	-0.2	-0.19
Entropy	4.79	4.56	4.3	4.29
Diff. var.	0.72	0.73	0.78	0.75
Diff. entropy	-0.17	-0.18	-0.26	-0.21

4. CONCLUSIONS

Considering and comparing the features extracted evaluated in the experimental results the verification method is carried out for all the 100 samples from polyUdatabase resulting with an accuracy rate of 90.1% and FAR=0.1,FRR=0.2.

The most important result in this system is our system is best with the perfection by rejecting the fake Palmprints meaning duplicate prints made of plaster and olefin material or simply the picture of a palm drawn in a paper and tested under our system is displayed as "invalid file" as an error message, Despite not much accuracy obtained this output can add more weightage to our palmprint biometric system.

In future we try to concentrate on real time biometric systems and databases with more complexity such pictures captured by handheld devices, mobiles, PDA's etc and deal with the greater accuracy rate with these requirements.

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