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Palm Print Recognition Using Gabor Filter and Back Propagation Neural Network

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ABSTRACT

Biometrics based person authentication methods are getting wide acceptance and they are replacing passwords because they are unique and secure. Palm print based person identification method is a technique which is more secure compared to other biometrics technique like finger print recognition, iris recognition, and face recognition. Palm print recognition provides a unique identification of the people. Palm print identification method compares the input palm images with the images in the database. If the features of the sample palm images are matched with the features of the image of the palm in the database then it is considered as positive. In this proposed method, left and right palm print images of an individual are taken in six different orientations are taken. The orientation features are extracted using Gabor filter because it has multi-resolution and multi-orientation features. The orientation of the filter which gives the maximum filter response with the palm print is taken as the most dominant orientation of the palm print. Artificial neural network is used for classification because neural networks have the ability to learn complex input-output relationships. The learning process involves updating network architecture and connection weights so that the network can perform a specific classification efficiently. The back propagation neural network is used here. The back propagation is a multi-layer feed forward, learning network based on gradient descent learning rule. The back propagation neural network gives various performance analysis, error histogram, training state, confusion matrix and receiver operating characteristics graphs. This method provides better accuracy.

***Keyword:* Gabor filter, Back Propagation.**

1. INTRODUCTION

Biometrics is a field of science and technology whose aim is the verification of a person's identity based on his/her behavioral or physiological characteristics. Biometrics needs a person to be physically present at the point of authentication. Biometrics provide a highly secure person identification and verification. Physiological characteristics in biometrics are a fingerprint, palm print, hand geometry, face, iris, ear and retina whereas behavioral characteristics are voice, signature, lip movement, gestures etc. [1] Fingerprint-based personal identification has drawn considerable attention over the last 25 years. However, workers and old people may not provide clear fingerprints because of their problematic skin caused by physical work. Recently, voice, face, and iris-based verifications have been studied extensively. Palm print recognition system is a promising technology which received considerable interest. Among various Biometric identifications technologies, palm print recognition system has been successful due to its simplicity, feature extraction, matching feature, small size, high precision, real-time computation, and the resolution of used images [2]. Palm is the inner surface of hand between wrist and fingers. The inner surface of palm contains three flexion creases, secondary creases, and ridges for each finger. The flexion is also called as principal lines and secondary creases are called wrinkles. Palm feature also includes singular points, ridges, wrinkles, and Delta, datum and minutiae points. Palm features are unique for every individual and have rich information that can be used for feature extraction. The palm lines and wrinkles are formed during the third and fifth month of the formation of the fetus. The wrinkles, ridges, principal lines namely heart lines, headlines; life lines are shown in the fig.1.1 [3].

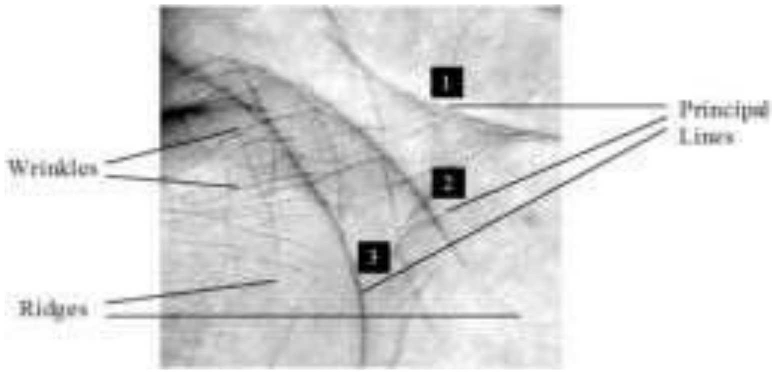

Fig 1.1: Palm Features

Palm print features are considered promising in identify people. There are two types of palm print features with reference to the field at which palm print systems are used. The first type of features are the principal lines and wrinkles which could be extracted from low-resolution images (<100 dpi) and it is used for identification in the commercial applications. The second type of features are the singular point, ridges and minutiae point which could be extracted from high-resolution images (>100dpi) and it is used for forensic applications such as law enforcement application. A region of interest (ROI) is extracted from the palm area for processing. Palm recognition process includes feature extraction (stored as a template in the database) matching (input query features are matched with stored features) and decision making (to accept or reject the query based on match score) [2].Once the central part is segmented, features can be extracted for matching. There are two types of recognition algorithms, verification, and identification. Verification algorithms must be accurate. Identification algorithms must be accurate and fast (matching speed). Verification algorithms are line-based, subspace-based and statistic-based. Line-based approaches either develop edge detectors or use existing edge detection methods to extract palm lines. These lines are either matched directly or represented in other formats for matching. Subspace-based approaches also called appearance-based approach in the literature of face recognition. They use principal component analysis (PCA), linear discriminant analysis (LDA) and independent component analysis (ICA).The subspace coefficients are regarded as features. Various distance measures and classifiers are used to compare the features. Statistical approaches are either local or global statistical approaches. Local statistical approaches transform images into another domain and then divide the transformed images into several small regions. Local statistics such as means and variances of each small region are calculated and regarded as features. Gabor, wavelets, and Fourier transform have been applied. [4]

1.1 Objective

In our day to day life, we are bound to prove our identity and there are lot of verification process. Normally they are performed through the use of a password when pursuing activities with line domain access, single sign-on, application login etc. so the personal identification and verification become essential. Palm print is believed to have the critical properties of universality, uniqueness, permanence and collectability for personal authentication. Palm are large in size and contains the abundant feature of different levels, such as creases, palm lines, texture, ridges, Delta points, and minutiae. Faking a palm print is more difficult than faking a fingerprint because the palm print texture is more complicated and are seldom leaves his/her complete palm print somewhere unintentionally. Also, compare to fingerprint palm are more robust to damage and dirt [5].The main objective of this project is to develop a recognition system based on palm print features and to apply Gabor filter to extract the features of the palm print images. To model the recognition of the extracted features using Back Propagation Neural Network and to develop a recognition system with higher accuracy, less time-consuming.

1.2 Scope

Palm print recognition system can be used in many application in day to day life. They can be used in forensic, civil and commercial applications. Palm print is preferred compared to other methods such as fingerprint or iris because it is distinctive, easily captured by low-resolution devices as well as contains additional features such as principal lines. Iris input devices are expensive and the method is intrusive as people might fear of adverse effects on their eyes. Fingerprint identification requires high resolution capturing devices and may not be suitable for all as some may be finger deficient. Palm print is, therefore, suitable for everyone and it is also non-intrusive as it does not require any personal information of the user. Palm print images are captured by acquisition module and are fed into recognition module for authentication.

1. Compared with face recognition palm print is hardly affected by age and accessories.

2. Compared with fingerprint recognition palm print images contain more information and needs only low-resolution image capturing devices which reduce the cost of the system.
3. Compared with iris recognition the palm print images can be captured without intrusiveness as people might fear of adverse effects on their eyes and cost effective [5]

2. METHODOLOGY

A biometric system which uses a palm print of a person for authentication/verification is shown in fig 2. The processing level includes image acquisition level, feature extraction level, match score level and decision level. The basic level of processing is same for all the biometric system. The complexity lies in the implementation of processing using different approaches and methods.

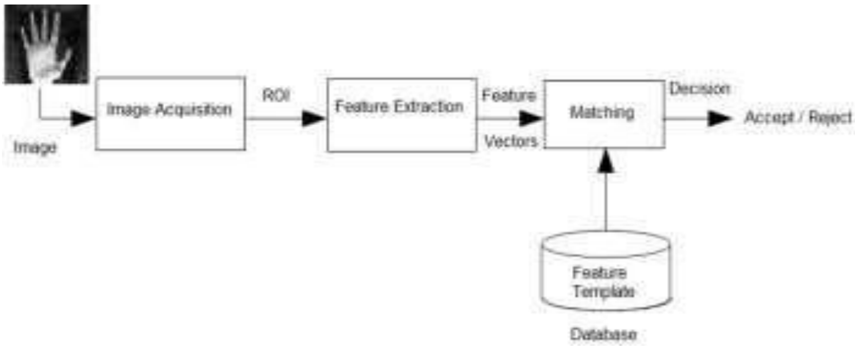

Fig 2: Palm Print Recognition System

2.1 Sensor Level

It is the first step in any biometric system where the image of the palm is captured for person identification. Different types of sensors like palm scanners, digital cameras, high and low-resolution cameras are used for image acquisition. Depending on the applications sensors are chosen. For a civilian, commercial applications low-resolution images and for forensic, criminal detection high-resolution images are used for processing. Figure 3 shows various palm images collected by different sensors [4]

2.2 Pre-Processing

The goal of preprocessing is to extract the region of interest (ROI) from palm print image. The principal lines are significant and minutiae and textures are used as unique information in forensic.The pre-processing steps involve converting the image to binary, extracting the region of interest and segmenting, keypoint detection and establishing the coordinating system. Extracting the region of interest is carried out using many methods. Centre of the palm is used as the region of interest in many methods as it covers most of the palm features and has a unique texture for each person. To extract the center of palm image first it has to be aligned and oriented to crop the center portion. The method proposed in, which extracts the central region of the palm print, is employed here. We first use the low-pass Gaussian filter to convolve the original palm print image and convert the convolved image into a binary image by thresholding the resultant convolved image and obtain the boundaries of the binary image. Then, we use the gaps between fingers as reference points to determine the ROI of the palm print. In other words, we determine the landmarks based on the boundaries, which are at the bottom of the gaps between the index and middle fingers and between the ring and little fingers. The line connecting these two landmarks is considered to be tangential to them. After that, we locate the bisector that is perpendicular to the tangent between two landmarks to determine the centroid of the palm print region. Finally, we extract the normalized sub-image of a fixed size, i.e., 64×64, as the ROI, which is located in a certain area of the palm print. Fig 3.shows the procedure for extracting the ROI of a palm print image

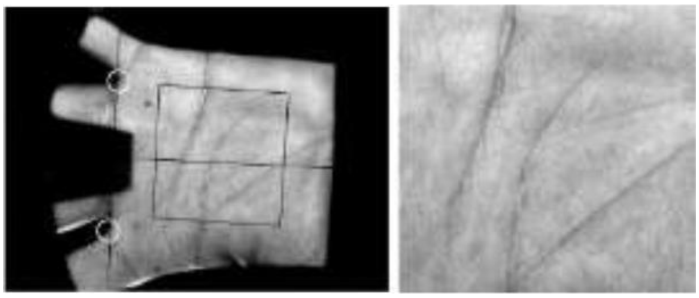

Fig -3: ROI extraction of a palm print image. (a) Original palm print image (b) ROI extracted from (a)

2.3 Feature Extraction
Feature extraction of ROI of an image is to locate the points those lie along boundaries i.e., set of pixels that either separate objects from one another or change in the surface geometry of an object. The Gabor filter is the most appropriate one for capturing the orientation information from palm lines. This is mainly because it has good properties of 2-D spectral specificity of textures as well as their variations with the 2-D spatial position. The typical circular Gabor filter has the following general form:

$$(\ ,\ ,\ ,\ ,\ ) = \frac{1}{2\ ^{2}} \exp\{-(\frac{\ ^{2}+\ ^{2}}{2\ 2}\}\exp(2\ (\ +\ ))\quad (1)$$

where $i = \sqrt{-1}$, μ is the radial frequency in radians per unit length, θ is the orientation of the Gabor function in radians, and σ is the standard deviation of the elliptical Gaussian along x- and y-axes, respectively. The parameters are empirically set as $\mu = 0.0916$, and $\sigma = 5.6179$. The real part of the Gabor filter is used to extract the neighboring direction indicator of the palm print image. Six Gabor filters with the orientation of $j\pi/6(j = 0, 1... 5)$ are also employed to extract the features of the palm print. They are first used particularly to convolve with the palm print image. [17]

2.4 Matching
If the left-side filter response is larger than that of the right-side; otherwise, it is encoded into 0.

2.5 Back Propagation Neural Network
A typical back-propagation network [with Multi-layer, feed-forward supervised learning is as shown in the Fig -4. Here learning the process in Back-propagation requires pairs of input (and target vectors. The output vector "o" is compared with target vector "t". In the case of difference of "o" and "t" vectors, the weights are adjusted to minimize the difference. Initially, random weights and thresholds are assigned to the network. These weights are updated every iteration in order to minimize the mean square error between the output vector and the target vector.

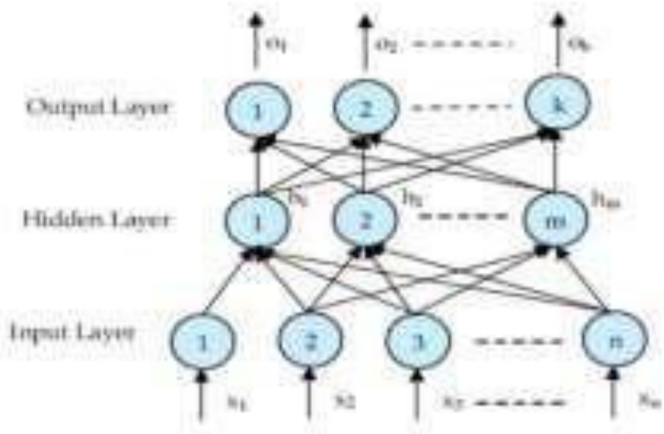

Fig -4 Basic blocks of Backpropagation neural networks

3. RESULT AND ANALYSIS

This touchless palm print image database mainly consists of the hand images collected from the students and staff at IIT Delhi, India. This database has been acquired in the Biometrics Research Laboratory during January 2006 - July 2007 using a digital CMOS camera. The acquired images were saved in bitmap format. This database contains left and right-hand images from more than 230 subjects, using a very simple touch less imaging setup, and made available freely to the researchers. All the subjects in the database are in the age group 14-56 years and voluntarily contributed at least 5 hand image samples from each of the hands.

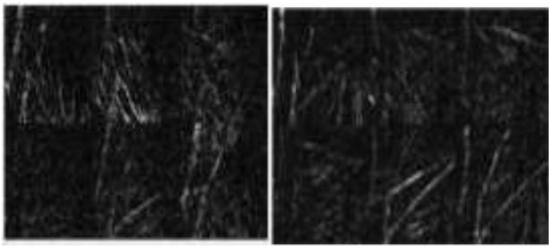

Fig-5: Feature extracted image of real part (left and right palm respectively)

Back propagation neural network is used here. Levenberg- Marquardt algorithm is used. The 7 features are extracted and there are 10 hidden layers here. The outputs are either classified as 0 or 1. Here the output class is 1. The figure below shows the recognition tool which produces various graphs such as performance graph, training state, and error histogram and roc curve. This window shows that the data has been divided using the divider and function, and the Levenberg-Marquardt (trainlm) training method has been used with the mean square error performance function. During training, the progress is constantly updated in the training window. Of most interest are the performance, the magnitude of the gradient of performance and the number of validation checks. The magnitude of the gradient and the number of validation checks are used to terminate the training. The gradient will become very small as the training reaches a minimum of the performance. If the magnitude of the gradient is less than 1e-7, the training will stop. The number of validation checks represents the number of successive iterations that the validation performance fails to decrease. If this number reaches 6 (the default value), the training will stop.

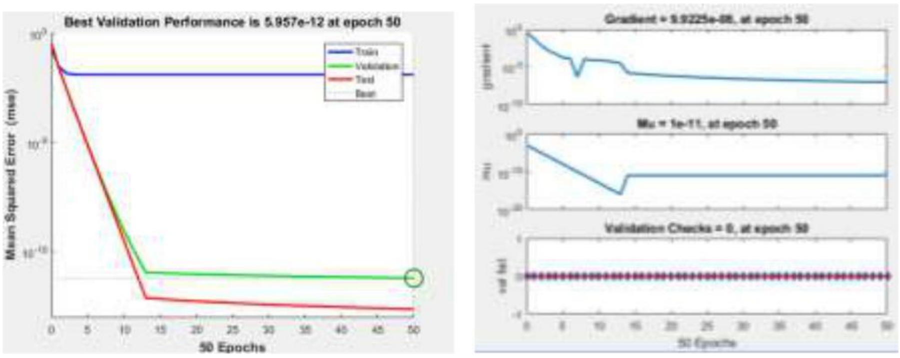

Fig-6 Performance plot and Training Process

On the confusion matrix plot, the rows correspond to the predicted class (Output Class), and the columns show the true class (Target Class). The diagonal cells show for how many (and what percentage) of the examples the trained network correctly estimates the classes of observations. That is, it shows what percentage of the true and predicted classes match. The off-diagonal cells show where the classifier has made mistakes. The column on the far right of the plot shows the accuracy for each predicted class, while the row at the bottom of the plot shows the accuracy for each true class. The cell in the bottom right of the plot shows the overall accuracy.

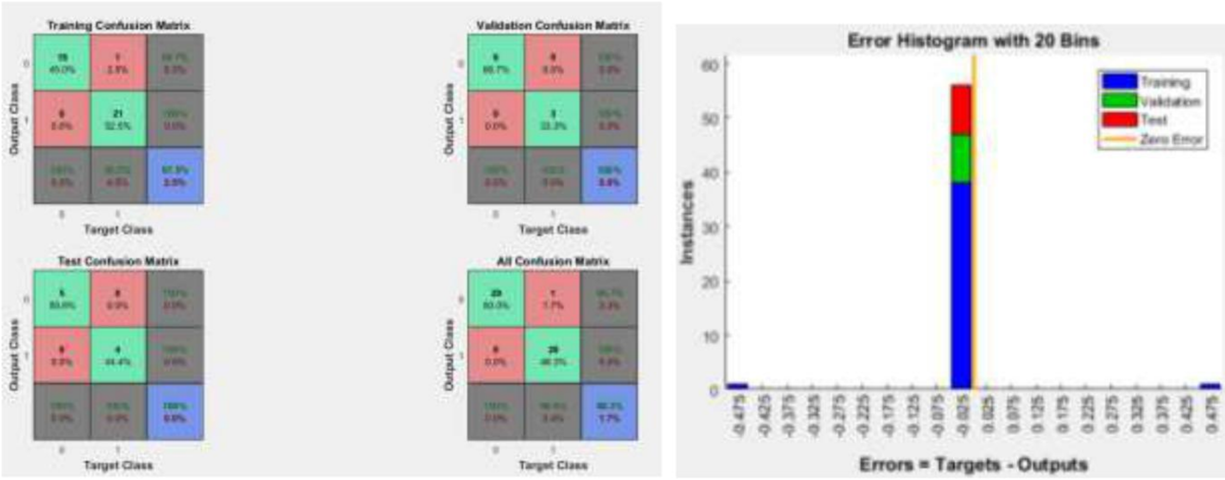

Fig-7 Confusion Matrix and Error Histogram

In the error histogram, the blue bars represent training data, the green bars represent validation data, and the red bars represent testing data. The histogram can give you an indication of outliers, which are data points where the fit is significantly worse than the majority of data.

4. CONCLUSIONS

Palm print recognition is a promising method for person identification. Here person identification is performed successfully using Gabor filter and back propagation neural network. The orientation based method which uses six Gabor filters with different orientations to convolve a palm print image. The different orientations of the palm print are taken to identify the most dominant orientation using Gabor filter. The classification is performed using back propagation neural network in order to minimise errors. The levenberg-marquardt training algorithm is used to create, train, and test the neural network for palmprint recognition. The back propagation neural network uses 10 hidden layers and 1 output layer and is classified as output class 1. The training and testing phase in the system is done properly and the system shows good performance. The performance is measured by mean square error and data division is random. The experiments are performed on the IITD Database. The neural network gives a good performance, minimum error, and higher accuracy when compared with other methods. The work can be modified by using any other training algorithms or by changing feature extraction methods in future. The image resolution can be changed to better results but the performance has to be analysed.

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