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An Intelligent Approach for Age Detection Using Finger Prints

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Abstract **-**The forensic investigators always search for fingerprint evidence which is seen as one of the best types of physical evidence linking a suspect to the crime. Discrete Wavelet Transform (DWT), the Singular Value Decomposition (SVD) and Principal Component Analysis (PCA) has been used to estimate a person's age using his/her fingerprint. Mostly K nearest neighbor (KNN) is used as a robust classifier. The evaluation of the system is carried on using internal database of male and female fingerprints. Tested fingerprint is grouped into any one of the following five groups: upto 12, 13 -19, 20 -25, 26-35 and 36 and above. The sample database is taken with the value of both male and female. The objective of this paper is also to classify the right hand fingerprints and identify whether it belong to male or female and determine his/her age.

Keywords*- Gender Classification, Fingerprint, Discrete Wavelet Transform, Singular Value Decomposition, Principle Component Analysis, k nearest neighbor.*

I. INTRODUCTION

Digital Image Processing refers to processing of digital images by using digital computers. Digital Image processing has various steps for processing the image and will perform Object Recognition. Recognition is the process that assigns a label (e.g., "vehicle") to an object based on its descriptors. Many human body features have been used to estimate sex/gender. Some of recent examples include foot print ratio, metatarsals, humerus, long bones of the arm, foot shape, femoral head, foot and shoe dimensions, patella, teeth and radial and ulnar bone lengths. Biometric identification systems are widely used for unique identification of humans mainly for verification and identification. Fingerprint has been used as a biometric for the gender and age identification because of its unique nature and do not change throughout the life of an individual [1]. Gender and Age information is important to provide investigative leads for finding unknown persons. Existing methods for gender classification have limited use for crime scene investigation. In this work, gender and age of a person is classified from the fingerprint using DWT and SVD and PCA. In fingerprint, the primary dermal ridges (ridge counts) are formed during the gestational weeks 12-19 and the resulting fingerprint ridge configuration (fingerprint) is fixed permanently [2-3]. The patterns of ridges on our finger pads are unique: no two individuals, including identical twins have fingerprints that are not same. Also, the variability of epidermal ridge breadth in humans is substantial [4]. Dermatoglyphic features statistically differ between the sexes, ethnic groups and age categories [5]. It is proved by various researchers; a fingerprint can be processed for the sex determination [6-11]. Figure 1 illustrates the process of DWT, SVD and PCA based gender classification system.

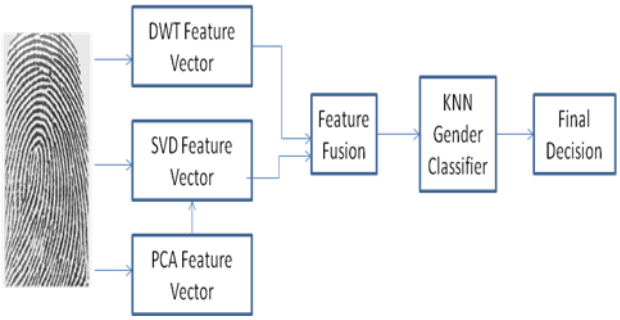

Fig.1 DWT, SVD and PCA based gender classification system.

Wavelet transform is a transform. Its provides the time frequency representation. In this work Discrete Wavelet transform used for gender classification.

II. LITERATURE SURVEY

Earlier work on gender classification based on the ridge density shows that the ridge density is greater for female than male [7, 8, 10,11] and [9] analyzed fingerprints of a tribal population of Andhra Pradesh (India) and showed the evident that the males showing higher mean ridge counts than females. A new approach for personal identification that utilizes simultaneously acquired finger vein and finger surface images is analyzed. This paper investigates two new score level combination approaches, i.e., holistic and nonlinear fusion, for combining finger vein and finger texture matching scores [12]. A new method for gender classification of fingerprint images based on levels using only DWT and SVD has been done [13]. The Fingerprint biometric is used to authenticate a person. Transform Domain Fingerprint Identification Based on DTCWT is proposed. The Fingerprint is preprocessed to a suitable size that suit DTCWT. The Fingerprint features are obtained by applying DTCWT with different levels.[14].

III. FINGERPRINT FEATURE EXTRACTION

For any pattern recognition, Feature extraction is fundamentally needed. For Feature extraction we have used the techniques of DWT, SVD and PCA. These techniques are discussed below.

A. DWT based Feature Extraction

DWT is a linear transformation that operates on a data vector whose length is an integer power of two, transforming it into a numerically different vector of the same length. It is a tool that separate data into different frequency components and the studies each component with resolution matched to its scale. 2D wavelet transform, decompose the image into 4 subbands. That is Low – low, Low – High, High – low, High- High. Most of the

energy presented in Low frequency. Since Low-Low energy band gives more information it is taken for applying decomposition applied. The energy of each subband is caluculated by using the equation (1)

$$E_k = \frac{1}{RC} \sum_{i=1}^{R} \sum_{i=1}^{C} \quad .....(1)$$

$X_k(i,j)$ → Which is the pixel value of thee k^{th} subband.

R,C → Which is the height and width of the subband.

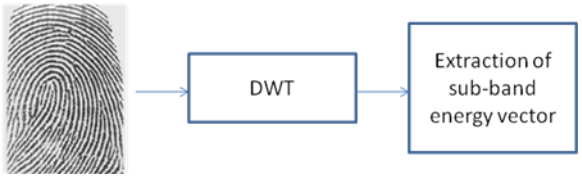

Fig.2 DWT based Feature Extraction.

B. SVD based Feature Extraction

A general rectangular M by N matrix A has a singular value Decomposition(SVD) into the product of an M by N orthogonal matrix U, anN by N diagonal matrix of singular value S and the transpose of an N by N orthogonal square matrix V,

A= U S V^ T

Calculate the eigen vector(V) using the equation(2)

[U S V^]=SVD(X)

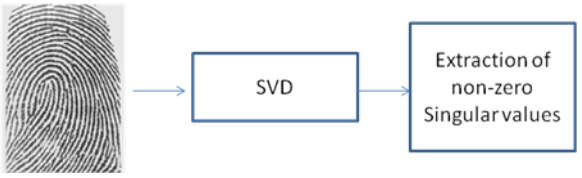

Fig.3 SVD based Feature Extraction.

C. PCA based Feature Extraction

The features are the principle components are orthogonal to each other and produce orthogonal weights.PCA is great for high dimensional data.

[V E] = eig(cov(X));

[E order] = sort(diag(E), 'descend');

V = V(:,order);

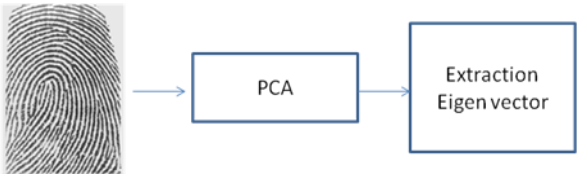

Fig.4 PCA based Feature Extraction.

The eigenvectors of the covariance matrix V are the principal components and the corresponding eigenvalues E represent the amount of variance explained.

IV. FUSION

The features extracted using the PCA is combined with SVD as both the techniques are closely related. Combine the feature vectors, subband energy vector(E), Eigen Vectors to form the feature vector for the training fingerprint. For example if an image size 500*550, then the subband energy vector size is generated as per the levels choosen and the eigen vector for PCA is 1*500. Then the resultant feature vector is of size 1*500+ as per the different levels choosen for performing DWT.

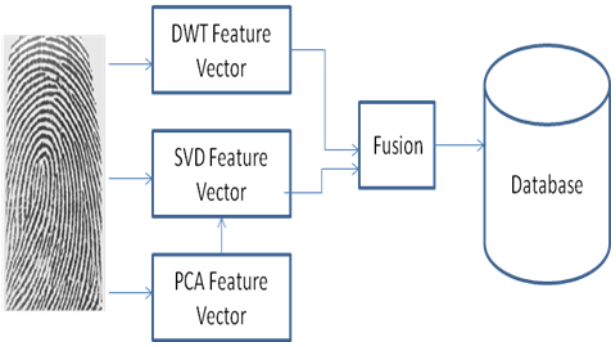

Fig.5 Gender Classification System

The feature vector contains the unique features of the fingerprints to be used for identification. The feature vectors for all the training set images are stored as a reference vector. If training set has 'n' number of images then the resultant vector is formed with 'n' number of rows with each row representing the feature vector of each training image. The number of columns represents the individual feature of the image vector for reference during the classification. The images are grouped from 1 to 10 as.

Table 1: Sample wise Details for Gender and Age

Gender	Age Group	Group
F	Upto 12	1
F	13-19	2
F	20-25	3
F	26-35	4
F	36 and above	5
M	Upto 12	6
M	13-19	7
M	20-25	8
M	26-35	9
M	36 and above	10

V. KNN CLASSIFIER

KNN classifies the sample image with reference to the trained vector stored. The images are classified using the trained set along with the grouping made in the previous step.

K nearest neighbor is used for classifying objects based on closet training examples in the feature space. The function used for Knn classification is as follows.

Class=knnclassify(sample,training,Group)
Sample → Testing image matrix
Training → Already trained fingerprint images.
Group → Vector whose distinct values define the grouping of the rows in training.

A. Classification Algorithm

Input : unknown fingerprint and the feature database
Output : The class of the fingerprint to which this

unknown fingerprint is assigned

Step 1: Decompose the given unknown fingerprint with different levels of decomposition using DWT.

Step 2: For each Level calculate the sub-band energy vector (E) using (2).

Step 3: Extract the non zero singular values using SVD.

Step 4: Calculate the Eigen Vector for PCA(V1) using (3)

Step 5: Fuse the Eigen Vector for PCA with the values extracted using SVD.

Step 6: Combine the vectors E,V and V1 to form the feature vector for the given training fingerprint.

Step 7: Apply KNN classifier and find the class of the unknown fingerprint by using the database generated using the previous steps.

VI. EXPERIMENTAL RESULT

A. Data Set

The fingerprint images of internal database were collected by using fingerprint machine digital persona 4100. The database includes 100 right hand thumb impressions collected from males and females of different ages. The images of all the fingers of the right hand was taken into consideration . So for each person five images were taken and stored in the database. The images are then trained. The collected fingerprint images are classified into various groups as specified in Table 1. The table shows the percentage of exact prediction of the unknown fingerprints.

Table1. Gender Classification using DWT, PCA and SVD

S.No	Thumb Finger	Pointing Finger	Middle Finger	Ring Finger	Little Finger
F UPTO 12	44.44	66.6	62.5	50	66.6
F 13- 19	50	70	33.3	44.4	37.5
F 20 – 25	50	60	66.6	50	50
F 26 – 35	50	50	71.42	57.14	71.42
F 36 & above	50	55.5	44.4	42.85	42.85
M UPTO 12	81.81	41.6	40	70	44.44
M 13- 19	75	75	75	75	80
M 20 – 25	100	100	100	100	100
M 26 – 35	80	75	75	66.6	66.66
M 36 & above	100	100	66.6	80	100

From the table we could understand that the prediction is upto …. percentage in case of female in the age group…

This gender classification can be applied for the academic data of the student and the performance can be analyzed. For example performance of the students in various groups (up to 12, 13-19, 20-25, 26-35 and 36 and above) as good / poor / average / excellent.

CONCLUSION

In this work, we have proposed a method to perform finger print gender classification by comparing the various features extracted. The features are extracted using SVD, DWT and PCA techniques. DWT extracts the frequency features and SVD the scalar features and PCA the Eigen values. The frequency features are extracted at various levels. The selected features are extracted from the training samples and are stored in a reference vector. The proposed method shows good result in finding gender classification and prediction. The result shows high prediction for female age group in 26 – 35 and male age group in 36 and above.

A. Future Work

Our feature work is to extend the proposed method of gender classification for both hands.

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