Fingerprint Based Age Estimation Obtained through 2D DWT, PCA and SVM

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Abstract— Fingerprints are the most widely used proofs for identifying the individual. fingerprint evidence is undoubtedly the most reliable and acceptable evidence till date in the court of law. Fingerprints are obtained at the site of crime and in many old monuments and in excavated things. In this work, we used human fingerprints as an evidence to determine the human age. Estimating the age of the fingerprints is an emerging field and many methods using the fingerprint physical features like the ridge count and the ridge thickness have been used so far. Due to the limitless potential of fingerprints as an effective method of identification an attempt has been made in the present work to analyze their correlation with age of an individual using frequency domain technique and a pattern recognition technique. Encouraged by the fact that human fingerprint differs in width ranging from birth to middle age but patterns remain unchanged. The combined processing has provided better results. This paper aims in using 2D- Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) combined to estimate a person's age using an obtained fingerprint. The Support Vector Machine (SVM) is used as a classifier. The obtained fingerprint image goes through two steps of feature extraction process and results in separate feature vectors which are then combined to produce a final future vector. The Support Vector Machine (SVM) was used as a classifier. 120 Fingerprints belonging to the various ages in between 1 –60 were taken for analysis. The experimental results show good for trained database. It was found that increasing the database population in each category improves the performance of the system. This method can be useful in crime investigations to reduce the search space of suspects.

Key words: Discrete Wavelet Transform, Principal Component Analysis, Support Vector Machine

I. INTRODUCTION

FINGERPRINTS are one of the most mature biometric technologies and are considered legitimate proofs of evidence in courts of law all over the world. Based on the varieties of the information available from the fingerprint we are able to process its identity along with gender, age and ethnicity. Within today's environment of increased importance of security and organization, identification and authentication methods have developed into a key technology. Such requirement for reliable personal identification in computerized access control has resulted in the increased interest in biometrics .A Fingerprint is the representation of the epidermis of a finger; it consists of a pattern of interleaved ridges and valleys. Fingertip ridges evolved over the years to allow humans to grasp and grip objects. Like everything in the human body, fingerprint ridges form through a combination of genetic and environmental factors. This is the reason why even the fingerprint of identical twins is different (Maltoni and Cappelli, 2006). The concept of fingerprint pattern being studied has been of significant use over time, when scanning it involves the conversion of fingerprint by small portion of light solid-state devices into alphanumeric formula (Galton, 1982). Fingerprint identification algorithms are well established and are being implemented all over the world for security and person identity. Very few attempts have been made to estimate the age from an obtained fingerprint. This is helpful for anthropologists for estimating the age from the fingerprints they obtain from excavated articles and for crime investigators for minimizing the rage of the suspects. The age of the person can be judged using the fingerprint of that concern person based upon the count or breadth of the ridges of the fingerprint. Ridge breadths differ more between regional populations than between males and females from the same population. The average ridge count is slightly higher in males than in females, with high standard deviation among subjects of both genders. Epidermal ridges and their arrangement (dermatoglyphic patterns) exhibit a number of properties that reflect the biology of an individual. Dermatoglyphic features statistically differ between the sexes, ethnic groups and age categories.

II. LITERATURE SURVEY

They proposed Analysis, design and implementation of human fingerprint patterns system "towards age &gender determination, ridge thickness to valley thickness ratio & ridge count on gender detection. The aim of their research is to analyze humans fingerprint texture in order to determine their Age & Gender, and correlation of RTVTR and Ridge Count on gender detection. The study is to analyze the effectiveness of physical biometrics in order to determine age and gender in human E.O. Omidiora, O. Ojo, N.A. Yekini, and T.O. Tubi[1]. They proposed Finger print Recognition Using Discrete Wavelet Transform. The most common approach for fingerprint analysis is using minutiae that identifies corresponding features and evaluates the resemblance between two fingerprint impressions. Although many minutiae point pattern matching algorithms have been proposed, Finger print recognition can be done effectively using texture classification approach K. Thaiyalnayaki, S. A. Karim, and P. V. Parmar[2]. They proposed the Fingerprint Based Male-Female Classification. Male-female classification from a fingerprint is an important step in forensic science, anthropological and medical studies to reduce the efforts required for searching a person. The aim of this research is to establish a relationship between gender and the fingerprint using some special features such as ridge density, ridge thickness to valley thickness ratio and ridge width Manish Verma and Suneeta Agarwal[3].have proposed

a method for Fingerprint Based Gender Classification through frequency domain analysis to estimate gender by analyzing fingerprints using 2D Discrete Wavelet Transforms (DWT) and Principal Component Analysis (PCA).A dataset of 400 persons of different age and gender is collected as internal databas Rijo Jackson Tom, et al, (2013)[4].have proposed a method for Age classification from fingerprints through frequency domain analysis to classify gender by analyzing fingerprints using 2D Bi-orthogonal Wavelet Transform. A dataset of 250 persons of different age and gender is collected as internal database. They have used wavelet entropy as a classifier and formulated equation is used as threshold for easy classification and achieve overall success rate in gender classification of around 58% Ajitha T.Abraham, Yasim Khan M,(2014)[5].

III. PROPOSED SYSTEM

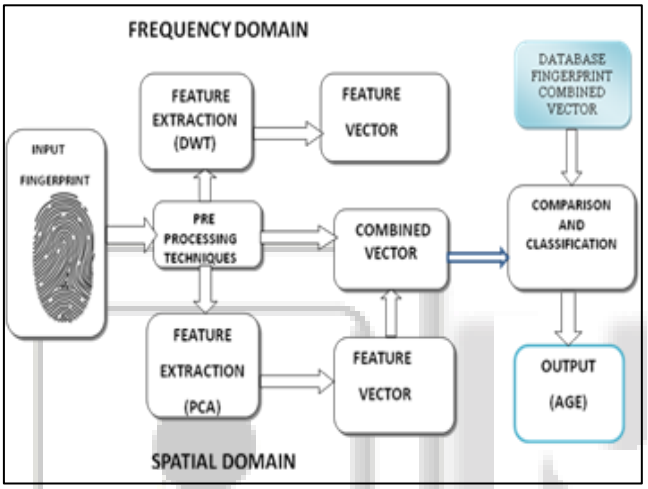

Fig. 1.1: Block Diagram

The paper is aimed in developing an algorithm for estimating the age through fingerprint obtained using 2D- Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) combined. Fingerprints are acquired real time and from the database sources. A fingerprint age estimating system constitutes of digital images of fingerprint as its input which is then transformed. Figure1.1 shows the generalized block diagram of the proposed system.

A. Preprocessing

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or a machine. Enhancements techniques like contrast enhancement, histogram equalization, biniarization, thinning and inverting are used as per the requirement of the image to be enhanced. The fingerprint is resized to 512x512. The fingerprint image obtained undergoes image enhancement for improving quality of the ridges and valleys. The input image which is gray scale is converted into binary. The output of preprocessing is shown in Figure 1.2

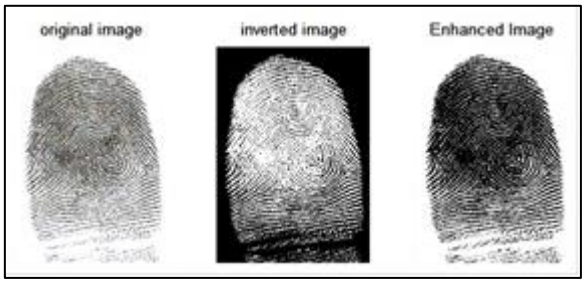

Fig. 1.2: Enhanced Fingerprint

B. DWT Feature Vector Generation

The fingerprint image undergoes discrete wavelet transformation for obtaining the feature vector. Wavelets have been used frequently in image processing and used for feature extraction, denoising, compression, face recognition, and image super-resolution. The 2-D wavelet decomposition of an image is results in four decomposed sub-band images referred to as low–low (LL), low–high (LH), high–low (HL), and high–high (HH). Each of these sub-bands represents different image properties. Typically, most of the energy in images is in the low frequencies and hence decomposition is generally repeated on the LL sub band only (dyadic decomposition). For k level DWT, there are (3*k) + 1 sub-bands available. The energy of all the sub-band coefficients is used as feature vectors individually which is called as sub-band energy vector (Ek). All fingerprints in the database undergo the decomposition and the energy vector of all the images is stored. Each of these

Sub bands energy is calculated using following equation (1)

$$Ek = \frac{1}{WB} \sum_{i=1}^{W} \sum_{j=1}^{B} \left| Xk\,(i,j) \right| \quad \text{— (1)}$$

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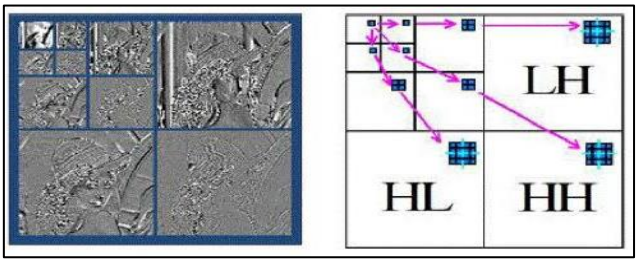

Fig. 1.3: DWT Feature Vector

C. PCA Feature Vector generation

PCA algorithms are generally implemented for pattern recognition systems. Principal component analysis involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. It is also named as the Karhunen–Loeve transform which is also called as

(KLT) the Hoteling transform. PCA involves the calculation of the Eigen value decomposition of a data covariance matrix or singular value decomposition of a data matrix, usually after mean centering the data for each attribute. The results of a PCA are usually discussed in terms of component scores and loadings. An Eigen vector of a given linear transformation is a vector which is multiplied by a constant called the Eigen value as a result of that transformation. The direction of the eigenvector is either unchanged by that transformation (for positive Eigen values) or reversed (for negative Eigen values).Every fingerprint in the database undergoes the PCA for obtaining the eigenvector. The eigenvector is 512 x 1 sizes and is stored as another feature vector of the fingerprint.

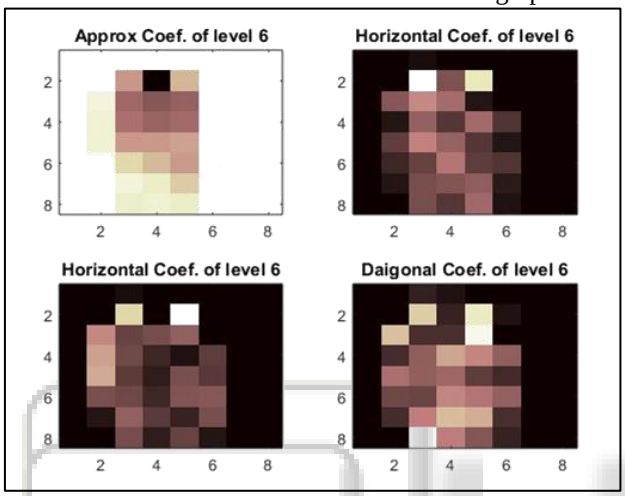

Fig. 1.4: Six level Decomposition

D. Combined Feature Vector

After undergoing DWT and PCA the feature vectors are stored separately. The next step is to combine both the feature vector into a single vector which stores the frequency domain and spatial domain information of a fingerprint. The 19 feature vector from the DWT and the 512 feature vector from PCA are combined to form 1 x 531 feature vector for a single fingerprint. Similarly for all the fingerprints in the database this procedure is followed and a database feature vector is created which contains all the feature vector of the images in the database. If there are *n* fingerprints in the database then the size of the database feature vector will be *n* x 531.A graph was plotted after obtaining the combined feature vector. Till date spatial features where used for analysis and is well established. We propose this system for the use of frequency domain analysis for the purpose.

E. Classification

The extraction of relevant features of a pattern is not a trivial task. For the particular case of the feature extraction from fingerprint images several approaches have been developed, most of them based on special characteristics from the fingerprint patterns, such as ridge orientation and minutia detection. The ridge orientation pattern of fingerprints is used to obtain feature vectors, which were used as inputs to statistical and neural networks classifiers. Several neural network models have been considered for the implementation of the fingerprint classifier. Depending up on the decision rule, all pixels are classified in a single class. Support Vector Machine (SVM) is used for classification of fingerprint into their respective class. In this proposed method we used Support Vector Machine (SVM) as a classifier. Application of SVM in fingerprint image classification problem consists of two phases: training and testing. During training, the SVM takes as input fingerprint image data that consist of positive and negative samples and the problem of separating a set of training vectors belonging to two separate classes is solved by training algorithm. The algorithm searches for an optimal hyper plane such that the distance to the support vectors is maximized. Verification of query fingerprint image is determined by classify each of user query fingerprint feature as belong to any of the two classes. The decision is based on the distance of the query data from the hyper-plane.

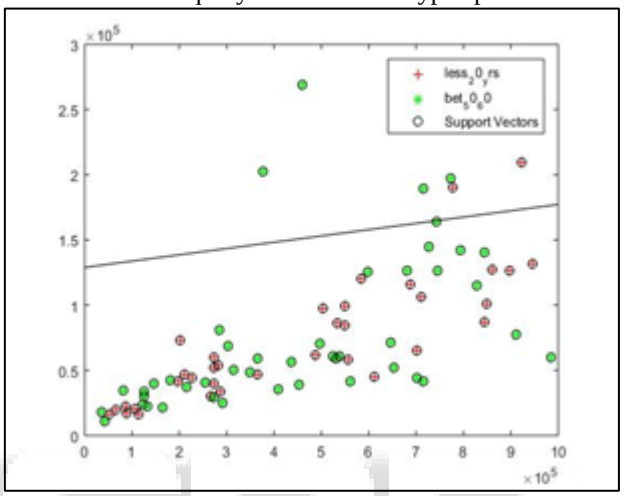

Fig. 1.5: SVM Classification

IV. AGE ESTIMATION

All the fingerprints used for our algorithm was taken from the database of Department of Biometric research, University of Ilorin. These fingerprints are optical scanned images. For Age estimation we divide the database into different age groups like less than 20, 21-30, 31-40, 41-50, 51-60.The fingerprints of different age group are grouped and kept as the database fingerprints .Once the desired database is formed all the fingerprints in it undergoes the feature vector extraction as explained in the previous section.

Steps to be followed for Age estimation using the query fingerprint:

1) The fingerprint undergoes preprocessing and is resized to 512x512.
2) The fingerprint undergoes Wavelet Decomposition and the 19 feature vector is obtained.
3) The fingerprint from the preprocessing stage also undergoes PCA Eigen vector feature extraction. This provides the Eigen vector of 512 sizes.
4) Now the features vectors are combined in total 19+512 = 531 vectors are obtained from the fingerprint.
5) This fingerprint feature vector is classified using the Support Vector Machine.

V. RESULT

The algorithm is developed based on MATLAB programming language. Algorithm executed and result obtained using MATLAB R2015a 8.1.0.430.

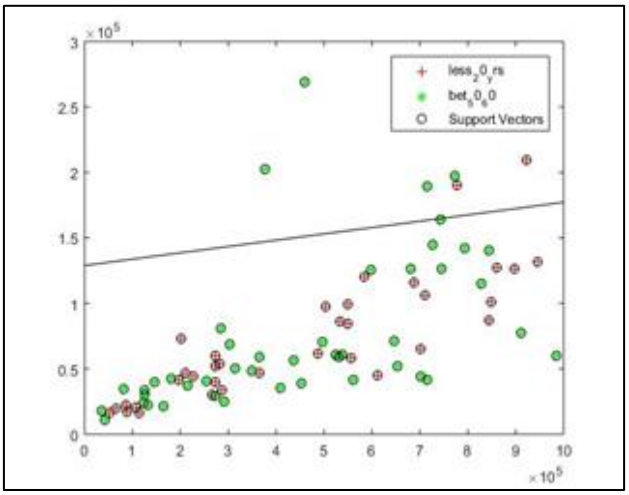

Fig. 1.6: output Classifier

AGE =Between 50_60

VI. CONCLUSION

In this work, we have proposed a new method of age estimation from fingerprint images based on level 6 DWT and SVD. The level 6 DWT is selected as optimum level by analyzing the results obtained for other levels. DWT and SVD also applied to classify the fingerprints into the four age group ages has been grouped as less than 20, between 20-30, 30-40, and 50-60.

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