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# Fingerprint Based Gender Classification Using Block-Based DCT

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**ABSTRACT**: Each person's fingerprint structure is unique and is developed for biometric authentication systems than others because fingerprints have advantages such as: feasible, differ from each other (distinct), permanent, accurate, reliable and acceptable all over the world for security and person identity. Fingerprints are considered legitimate proofs of evidence in courts of law all over the world.

Frequency domain based fingerprint classification can be done using block based discrete cosine transform, which uses cosine as a basis function that gives energy based features of an image. We are taking dataset of 1000 male and 1000 female fingerprints. Knn classifier is used as a classifier which uses Euclidean distance measure for classification and classifies testing fingerprint as male or female fingerprint.

This paper describes the overall process of above scheme. Some of dataset images are used for database creation (training images) and some for testing purpose (testing images). BBDCT transform will give the features of training sample images of dataset to create database of features which will be used as look up table for classification of unknown fingerprint and other fingerprints will be used for testing. Knn classifier will assign one of two groups to testing fingerprint.

**KEYWORDS**: fingerprint, block based discrete cosine transform, knn classifier, Euclidean distance, features of fingerprint.

## I. INTRODUCTION

Fingerprints are one of the most mature biometric technologies and are considered as legal proof 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 [1]. Within today's world 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 [2].

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. Fingerprint analysis helps in identifying the person responsible for an audacious crime. Fingerprints are also used for the gender and age identification because of its unique nature and do not change throughout one's life [3]. Existing methods for gender classification have limited use for crime scene investigation because they depend on the availability of bones, teeth, or other identifiable body parts having physical features. Gender determination of unknown person can guide investigators to the correct identity among the large number of possible matches, means reduces the search space.

The fingerprint gender classification can be studied using spatial domain and frequency domain approach. Spatial domain approach works on the pixel values of an image and works on the physical parameters of an image. In fingerprint image parameters related to ridges and valleys are the physical parameters. There are variations in ridge dimensions and sex differences in ridge breadth of every person. Fingerprint patterns exhibit number of properties that reflect the biology of individuals. Fingerprint features differ statistically between the sexes, ethnic groups and age categories. These features help in classifying a person [4].

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Ridge based gender determination have used the inked fingerprints and their findings are based on the spatial domain analysis of ridges. Generally ridge related parameters such as fingerprint ridge count, ridge density, ridge thickness to valley thickness ration, ridge width and fingerprint patterns and pattern types were used as feature for gender determination. The ridge thickness depends on the pressure applied and may provide false results on gender identification [4,5]. All the methods proposed based on the fingerprint ridges have given insight about the ridge parameters mentioned about but fails to give accurate method of measuring the parameters. Also the feature vectors obtained in these methods is of varying length and makes the calculations difficult.

The frequency domain approach works on the measuring parameters of an image rather than working on physical parameters of an image. That is frequency domain approach works on the frequencies of that image and uses energy of the image as feature of that image. Here, features are extracted using different methods, like Discrete Wavelet Transform, Discrete Cosine Transform, Fast Fourier Transform and Region Properties [6]. DCT transforms an image and provide energy based coefficients of an image. DCT is designed in such a way that most of the information of an image in contained in few coefficients. Another method based on DCT is block-based discrete cosine transform (BBDCT) which divides an image into n*n bocks (n=8, 16, 32, 64…) and gives the features from each block [7]. Whereas dwt works on wavelets, a waveform of effectively limited duration that has an average value of zero. In mathematical term wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale. Here the fundamental frequency is used for gender Classification [8]. These methods give feature vectors of fixed length which makes calculations easier, and can be mapped with other methods easily.

## II. LITERATURE REVIEW

Gender classification based on fingerprint can be done using spatial domain approach or frequency domain approach. Also it can be done using the combination of both approaches. Most of the works had based on the spatial domain parameters and few were based on frequency domain parameters. Gender classification based on ridge density shows that females have higher ridge density than male and analysed fingerprints of tribal population [9, 10]. Fingerprint have many parameters related to ridge like ridge distance, ridge period and ridge frequency, all these parameters have very important role in gender classification [11, 12]. Many of the studies on fingerprint gender detection were made by manual measurements from the inked fingerprints. Study based on fingerprint ridge count and ridge area to valley area ratio shows that male has higher ridge count than female and female have higher ratio compared to male [13]. Face recognition is based on the feature extraction which can be done using BBDCT, Fingerprint based gender classification is also based on feature extraction, so BBDCT can be applied to extract the features [7]. Some studies on fingerprint based gender identification using frequency domain approach and fingerprints were analysed using Fast Fourier Transform, Discrete Cosine Transform and power spectral density [8].

## III. PROPOSED WORK

The proposed project is divided into three sections, first is pre-processing of all dataset images, second is calculation of feature vector of all the dataset images using block based discrete cosine transform, the third is classification of testing fingerprint as male fingerprint or female fingerprint using knn classifier which uses Euclidean distance measure for distance calculation.

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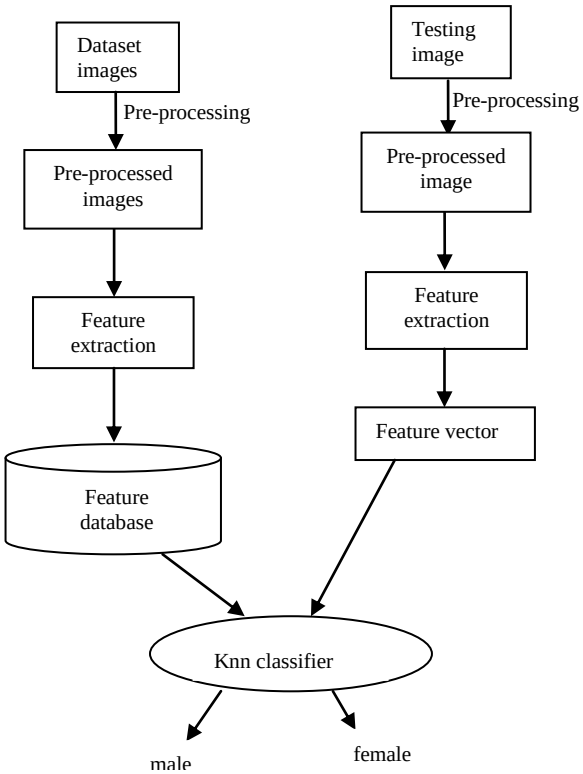


Fig.1. Over all process of gender classification

*A. Pre-processing:*

All dataset images are color images and are of different sizes, so in pre-processing all the images are converted or resized to same size (512*512). Ridge orientation, filtering is applied to get a fine pre-processed binary image. This makes the processing fast and reduces processing time.

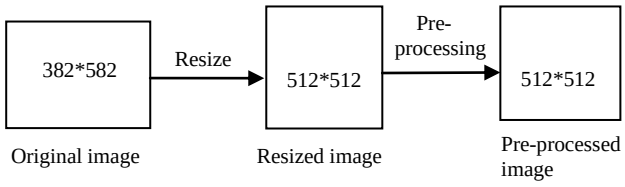


Fig.2. pre-processing

*B. BBDCT based feature extraction:*

We are working in the frequency domain approach which works on the measuring parameters of an image like frequency, pattern recognition and do not consider the physical parameters of an image which are based on ridges. We are using Block-based Discrete Cosine Transform for extracting the features of the fingerprint image. Dct uses cosine as its basis function which gives the energy based features of an image.

DCT expresses a finite sequence of data points in terms of cosine function oscillating at different frequency. Very few cosine functions are needed to approximate an image, which means it has strong energy compaction property. DCT uses cosine function to separate images into parts of differing frequency to give a coefficient matrix which depends on the horizontal, diagonal and vertical frequencies.

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DCT of an image consists of three frequency components low, middle, high. Low frequency components contain the average intensity or energy of an image. DCT has property that most of the visually significant information of an image is concentrated in just few coefficients of dct which we can use as features of that image. DCT is designed so that larger coefficients occur first and small later, based on this a raster scan order is defined based on energy carried out by that coefficient.

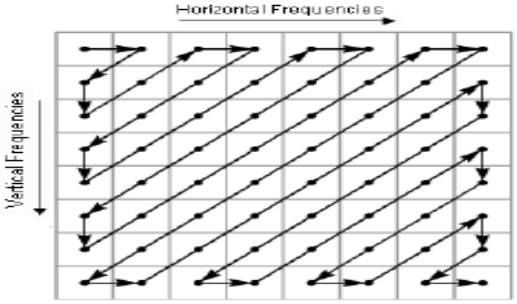


Fig.3. Raster scan order of dct coefficients

A formula to calculate dct coefficients of an image is

$$F(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{M-1}\cos\left[\frac{\pi u\ (2x+1)}{2N}\right]\cos\left[\frac{\pi v(2y+1)}{2M}\right]f(x,y) \qquad \text{eq. (1)}$$

$$\alpha(u)\alpha(v) = \begin{cases}\sqrt{\frac{1}{N}}\ for\ u,v \neq 0\\ \sqrt{\frac{2}{N}}\ for\ u,v = 0\end{cases}$$

Where, x and y are index values of an image of which coefficients have to be calculated. u and v are index values of dct coefficient image. M and N is the size of an image.

Fig.4. Image divided into blocks of 64*64

Block-based DCT divides an image into blocks of n*n (n=8, 16, 32, 64). We can choose an appropriate block size which gives better results with less number of features. We have divided an image of size 512*512 into blocks of 64*64 to get 64 blocks of an image. Apply DCT on each block of an image to get dct coefficients. Now choose very first dc coefficient as feature from each block, so taking very first coefficient from each block gives us 64 features. So, feature vector of size 64 is obtained from single image. Likewise using dct formula calculate bbdct coefficients of all the training sample images to create feature vector database. Arrange this database in two classes one is female class and second is male class.

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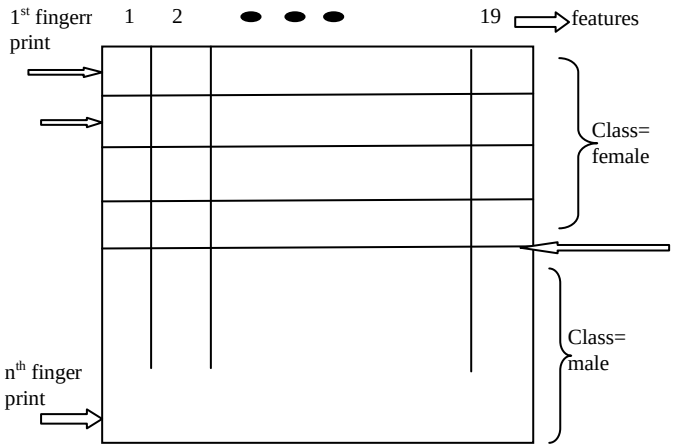


Fig.5. Database storing feature all the training images with their class

In database we are first storing the features of all female fingerprints that is first class is female class, then we are storing the features of male fingerprints so second class is male class. The testing fingerprint will be classified to one of two classes defined above.

*C. Classification of testing fingerprint*

Testing fingerprint which is to be classified as male or female fingerprint is taken as input. This image is also pre-processed in the same way as we have pre-processed training sample images and features are extracted using the same method used for training sample to get feature vector. K nearest neighbor (knn) classifier is used as a classifier which uses Euclidean distance measure for classifying testing fingerprint as male or female fingerprint. The testing fingerprint feature vector is compared with all the feature vector in database that is Euclidean distance is calculated between them. As we are having only two classes we will select odd number of k to break the ties. We are using 3nn classifier, where the 3 minimum distance vectors are selected and if two vectors are from female class then the testing fingerprint is of female class or otherwise it is of male class.

If we want to calculate the Euclidean distance between two vectors like

Vector 1 = {a b c ….} and vector 2 = {x y z….}

Euclidean distance = $\sqrt{|a-x|^2+|b-y|^2+|c-z|^2+\ ...}$

In this way we classify an unknown fingerprint as female fingerprint or male fingerprint.

## IV. RESULT

*A. Pre-processing*

An original image is pre-processed to give pre-processed binary image, which is used for feature extraction.

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Fig.6. Original image

Fig.7. Result of pre-processing step

*B. BBDCT based feature extraction*

A pre-processed image is then divided into blocks of 64*64 and dct is applied on each block separately and first coefficient s selected as feature from particular block. So that the size of feature vector of single image is equal to the number of blocks. In the same way calculate feature vectors of all training sample images to create database.

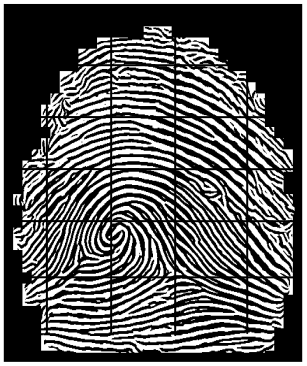

Fig.8. Pre-processed image divided into blocks of 64*64

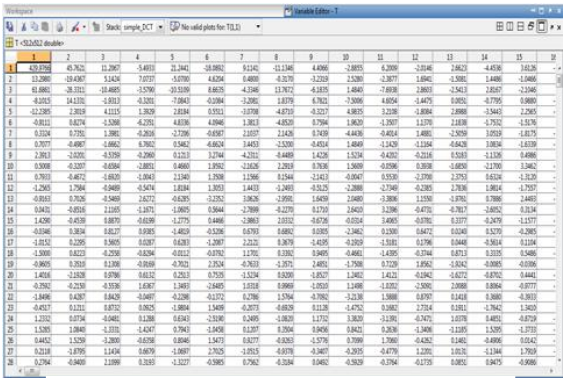

Fig.9. BBDCT transformation of an image

*C. Testing fingerprint classification*

- Input the testing fingerprint which we want to classify as male or female fingerprint.
- Calculate the feature vector of this image using BBDCT.
- Compare this feature vector with all the feature vectors in database using Euclidean distance.
- The minimum distance class will be the class of testing fingerprint.

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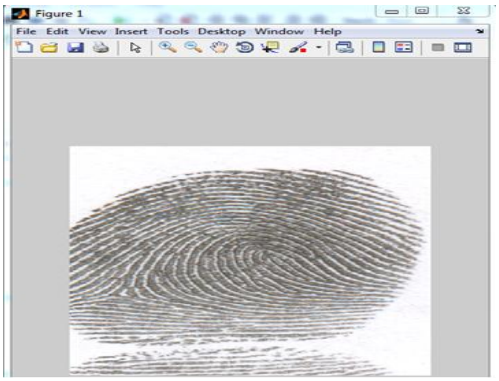


Fig.10. Fingerprint to be classified

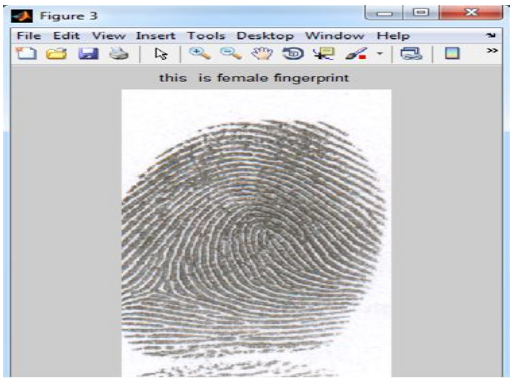


Fig.11. Resulted class of fingerprint

## V. PERFORMANCE ANALYSIS

The algorithm is written in MATLAB programming language. The process of feature vector extraction for the database is time consuming. We have used some of the dataset fingerprints for feature extraction and the rest is used for testing purpose. The result of the gender classification of 400 male and 400 female fingerprints is shown in Fig.12.

The success rate for female fingerprints is 65.25% and for male fingerprints is 45.25%. The overall success rate of proposed gender classification is around 55.25% for dataset we have used. Proposed gender classification used only on optical scanned Prints.

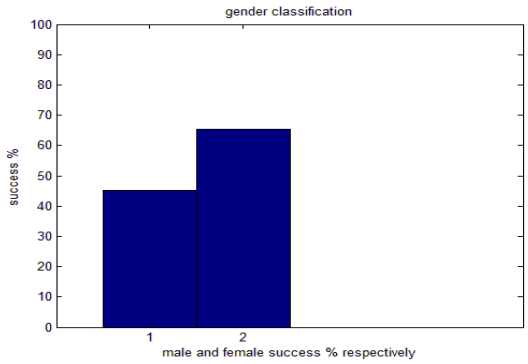


Fig.12. Success rate of proposed gender classification

## VI. CONCLUSION

The methods based on spatial domain approach the extraction of ridges from fingerprint and finding distance between them is tedious and require more time, also the feature vector obtained in this methods is of varying length and make the calculations difficult. The proposed approach takes less time and feature vectors which we get is of fixed length which make the calculations easier and can also be mapped to other methods easily.

## VII. FUTURE WORK

In future, the work will be extended by combining spatial domain and frequency domain approaches to find different parameters like age, rural, urban people. Also different features which will help in gender classification which will be more accurate and suitable for all types of application. We can also use different frequency domain approaches or else can use the different combination of methods which gives improved result.

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