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# A Hybrid Model of Wavelet Transform and Artificial Neural Network for Gender Classification

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## ABSTRACT

*In this study, we propose a system for gender classification from facial images by combining hybrid model of wavelet transform and neural network based on texture, information of colour and shape for achieving optimal classification. We use Daubechies wavelet transform at different levels to decompose the main image into sub images for analysis and feature extraction. The classification is based on feed-forward back propagation neural network. The decomposition coefficients obtained by wavelet transform are used as input vector for neural network. This study uses 500 images of FERET database that include both male and female gender. The experimental results show that the proposed method has more than 91% classification efficiency with both training and testing datasets.*

***Keywords: Daubechies Wavelet, Gender Classification, Neural Networks, Wavelet Transform and Facial Images*** .

## I INTRODUCTION

Gender classification has been an active and promising field of research for the last more than one decade and is quite exciting too. Humans have tremendous potential of differentiating gender from facial images. Due to inherent variability in human faces, there are numerous challenges in automated gender classification methods.

Gender classification from facial images is a two-class pattern recognition problem and is an open field of learning in applied research as well as in many fundamental applications [1]. Many applications such as biometric systems are making successful use of facial image analysis. For any pattern recognition algorithm, the difficulty arises from inherent variations in the images captured by any device. Although many techniques have been successfully used to classify facial images based on gender, yet wavelet transform is today considered as most powerful and successful method for pre processing of data for analysis and feature extraction.

To extract the required information from an image it is important to analyze all the features that describe an image at different resolution levels and wavelet transform is an ideal tool to analyze images of different gender by decomposing images into different scale orientations, providing a technique for in space scale representation.

In this study, Discrete Wavelet Transform with Daubechies wavelet function is applied to images for denoising and feature extraction. We classify the gender by artificial neural network using back propagation algorithm.

The proposed technique performs well on images containing variations in facial expression, aging effects and lighting etc.

## II BRIEF LITERATURE REVIEW

From past more than one decade, there has been an extensive research on various aspects of human face recognition by machines using various techniques. Principal Component Analysis (PCA) was among one of the Face-based approach's that attempts to capture and define the face as a whole. It treats the face as a two-dimensional pattern of intensity variation and the face is matched through identifying its underlying statistical regularities. This approach has proven to be an effective one[3-9]. However common PCA-based methods suffer from two limitations, namely, poor discriminatory power and large computational load[10].

A gender classification based on a fingerprint using Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD) is used in [11] to analyse the gender of an individual. The feature is generated by extracting the energy of all the sub-bands of DWT combined with the spatial features of non-zero singular values of the SVD of the fingerprint. The study gave accuracy up to 80.40% for male and 76.84% for female.

Fast Fourier Transform (FFT), Discrete Cosine Transform (DCT) and Power Spectral Density (PSD) is used to generate fingerprint features in [12].The authors argue that transformations generate most of the information of the spatial domain image which can used to estimate the gender by comparing them with predefined values. The study shows that the proposed method gave 90% accuracy on female samples and 79.09% on male samples.

A Level 6 Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD) is used in [13] to classify gender based on the fingerprint. This study combine the energy of sub-band of DWT and the spatial features of non-zero singular values obtained from SVD as input to K nearest neighbor (KNN). The study reported that this method achieved an accuracy of 91.67% for male and 84.69% for female.

A 2D- Discrete Wavelet Transform (DWT) is combined with Principal Component Analysis (PCA) to generate a vector feature in [14] and gender fingerprints are classified by implementing the minimum distance method for fingerprints of 200 males and 200 females of various age groups. This study reported that the success rate of the proposed method is around 70%.

A combined method of classification of image by wavelet transform and neural network is proposed in [15].This new approach of classification of image is based on the texture, information of colour and shape. The study use daubechies 4 type of wavelet transform to decompose the main image into sub images to extract features and back propagation neural network is used as image classifier. Resulting data consist of 98% and 90% efficiency for training and testing respectively.

An Improved gender classification using Discrete Wavelet Transform and hybrid Support Vector Machine is proposed in[16]. The study uses one hundred images for a training set and the proposed method reached an accuracy level of 90%, whereas the author claims that the best method known from the literature tested under the restrictions imposed on the database, achieved only 78% accuracy.

## III METHODOLOGY

The proposed technique includes application of 2D-Stationary Discrete Wavelet transform (SDWT) on the facial images. We use Daubechies wavelet function at different levels to decompose the main image for denoising, analysis, and feature extraction. The best results were obtained at Level 5 and the resultant wavelet coefficients are stored in a file. During the training phase, the artificial neural network is trained using back propagation algorithm with 350 images in the dataset that includes values of corresponding coefficients with a label 0 for male and label 1 for female images. Similarly, 150 images from the dataset are used in testing phase. Finally, gender classification rate is calculated in terms of Mean Squared Error (MSE)and Region of Convergence(ROC).Hence, gender classification is achieved in two main steps. In the first step, features are selected from the facial images and in the second step, the selected features are classified using artificial neural network classifier. Following are steps of the proposed technique:

1. Read all images one by one.
2. Convert all RGB images into gray scale to form 2D matrix.
3. Apply the 2D Stationary Discrete wavelet transform (SDWT).
4. Take the coefficient of all images, along with the label (0 for male, and 1 for female)
5. Train the dataset of coefficients using artificial neural network.
6. Test the images using artificial neural network.
7. Calculate the gender classification rate.

The frame work of the proposed model is depicted in Fig. 1. At each level of wavelet decomposition, 4 new images are formed from the original image (Fig. 2) and 4 new images have a reduced size i.e., $1/4^{th}$of the original image. Filters are applied to the images in horizontal and vertical directions. The four decreased images are LL, HL, LH and HH.The LL is the reduced form and contains the most information of the image.The HH image is noisy because it contains high-frequency information.LH image represents horizontal edge features while HL represents vertical edge features.

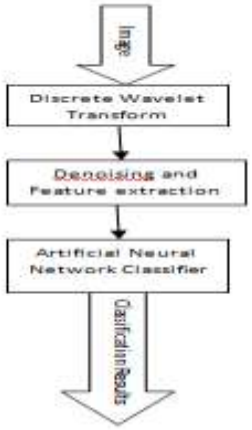


**Figure 1: Framework of Proposed Model**

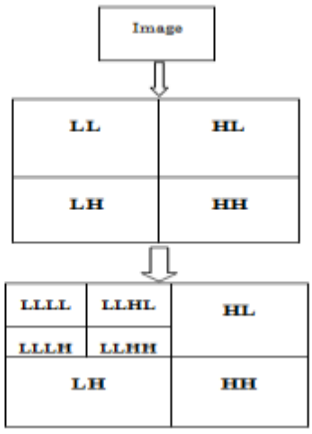


**Figure 2: 2-Level 2D Wavelet Decomposition**

The proposed system is implemented in MATLAB that includes automatic thresholding and proceeds in three steps:

1. Decomposition.
2. Thresholding detail coefficients.
3. Reconstruction.

Wavelets can decompose any given function or signal into components of different scales. There are two types of wavelet transform, i.e., Discrete Wavelet Transform and Continuous Wavelet Transform. The analysing wavelet is shifted smoothly over the full domain of the analysed function during its computation in the continuous wavelet transform. Since it is difficult to analyse any data when wavelet coefficients are calculated at every possible scale, it is rather more accurate and faster to choose the scales by the power of two. Only discrete wavelet transform is used in this study. Several types of wavelets such as Haar, Daubechies, Symlets, Coiflets are available for the reduction of noise any of these wavelet functions can be used to analyse the image at different levels and scales [2]. For our study only Daubechies wavelet function is used at different levels for denoising purpose. In our study, wavelets de-noise the image and this reconstructed (and de-noised) image is fed to the neural network as its input for classification of gender. The model is trained in a process called supervised learning in which the input and output are repeatedly fed into the neural network. The model output is matched with the given target output and an error is calculated with each presentation of input data. With the goal of minimizing the error and achieving simulation closer and closer to the desired target output, the error is back propagated through the network to adjust the weights. To train the network, the feed-forward back propagation algorithm is used and the classification results are obtained.

## IV DATA

This study uses the image dataset called FERET Database. We selected 500 RGB images from this database of both male and female gender. These images contain variations in facial expressions, age effects and lighting etc. In this work, we collect 500 face images out of which 250 faces are male and rest 250 images are female.

## V RESULTS & DISCUSSIONS

While preparing the dataset for classification the images were subjected to various levels of wavelet transforms so as to find an optimum set of feature vectors for the classification model. While testing at different levels of discrete wavelet transform of level 5 of the Daubechies wavelet gave an optimum value for features.

Different set of feature vectors which were obtained from discrete wavelet transform were concatenated to form a single feature array for both male as well as female class forming a two-class problem. Artificial Neural Network was trained using these feature vectors and during training it was observed that an optimum number of

epochs were to be used. Lesser no of epochs would result in underfitting while as using larger number of epochs would result in overfitting, hence using an optimum number of epochs was essential.

**Figure 3 (a,b): Decomposed & Residuals of a female and a male image.**

With increasing level of decompostions and adding more number of neurons, the classifiaction rate become better, however at a certain point the system converges and the efficency rate is found about 90% for women and 92% for men.Fig.4 shows an accuracy of 91% for 70% training, 15% validation and 15% testing with mean square error of 0.027.

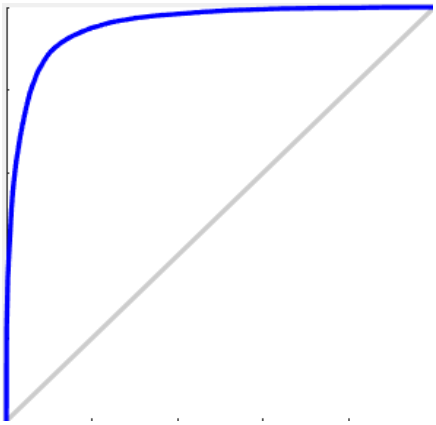

**Figure 4: ROC**

**Table 1: Comparison Table**

| Classifier | Coefficients Type | Recognition Rate (%) |
|---|---|---|
| MLP/BP NN [10] | WT+PCA | 90.35 |
| MLP/BPNN[10] | WT | 89.45 |
| MLP/BPNN [10] | LDA | 89.24 |
| MLP/BPNN [10] | PCA | 81.27 |
| MLP/ BPNN | SDWT (Proposed Method) | 92 |

## VI CONCLUSION

The proposed system is a combination of Daubechies Wavelet Transform for feature extraction and Artificial Neural Network as Classification model. The proposed model is an effective classification system of gender having a better classification rate than most of the traditional classification models.

During our study it was seen that more number of features were desirable giving higher accuracy, however at the same the curse of dimensionality would settle in.

In future the system's accuracy can be increased by using a multimodal system in which a number of quantifiable features such as Speech, Gait, Thumb Print, Lip Motion etc can be are used. Creating such a system would also secure it against the attacks of an impostor, but development of such systems mainly depends on the level of co-operation of public masses on sharing their personal biometric data.

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