[1].Images are preprocessed first before finding edge information. Canny edge detection algorithm allows for finding edges in an image. The proposed technique is a five step procedure; (1) In first step we preprocess image to resize it fixed dimension. (2) In second step edge tracking of facial regions such as eyes, nose and mouth is done. (3) In the third step discrete wavelet transform is applied on edge tracked face images.(4) In the fourth step directional information is calculated using multilevel multiscale wavelet coefficients to capture the variations of pose, expression, orientations. 5) Finally the fusion of the multilevel wavelet coefficients is performed that is generated from the above steps. Block diagram of proposed method is as shown in figure 1.

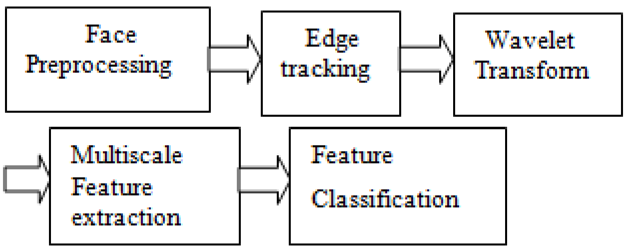

Figure 1: Block Diagram of Face Recognition system

3.1 Edge Detection

Edge detection plays an important role in feature extraction process as the edges of an image carry important information which need to be detected and enhanced in order to excel performance of face identification significantly. Edge tracking is an important step in determining structural information from an image. Using Canny edge detection algorithm edges are detected from background images. This algorithm runs in 5 separate steps:. Smoothing, finding gradients, Non-maximum suppression, Double thresholding, Edge tracking by hysteresis:

1) Smoothing
   Image is first smoothed by applying a Gaussian filter for remove noise present in images.
2) Finding Gradients
   Purpose of this algorithm is to detect edges where significant change in grayscale intensity of image. This intensity change is determined by finding gradients of the smoothened image. By applying sobel operator gradients at each pixel in the smoothed image are determined. Kernels are applied in X and Y direction to approximate the gradient in the x- and y-direction respectively. Face image of the gradient magnitudes represent the edges quite clearly. Width of the edges are typically broad and thus do not indicate exactly location of the edges. For detecting location of edges direction of edges are also calculated
3) Non-maximum suppression
   The purpose of non-maximum suppression is to convert the "blurred" edges in the image of the gradient magnitudes to "sharp" edges. This is achieved by keeping all local maxima in the gradient face image and deleting everything else.
4) Double thresholding
   The pixels obtained after the non-maximum suppression are considered as edge pixels. Some of edge pixels will probably be true edges in the image, but some edge pixels may be caused by noise. The simplest way to identify true edge pixels is to use a threshold, so that only edges stronger that a certain threshold value would be preserved. Double thersholding is used to identify strong edge pixels and weak pixels. Edge pixels exceeding to high threshold are considered as strong; while edge pixels which are below low threshold suppressed and edge pixels between the two thresholds are represented as weak.

5) Edge tracking by hysteresis
   Strong edges obtained after double thersholding considered in the final edge face image. Weak edges which are connected to strong edges are considered in final edge image. Strong edges only be due to true edges in the original image. This method avoids false identification of strong edges occurring due to noise. Strong edges can be considered in the final edge face image. Weak edges which are connected to strong edges are considered in final face edge image. Thus strong edges are only true edges in the original image. The weak edges may represent true edges or may be present due to noise.

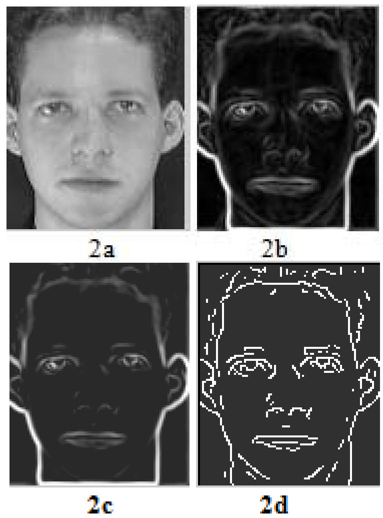

Figure 2: a) Original face image b) Gradient image c) After Thresholding d)After Thinning

3.2 Discrete Wavelet transform

Discrete wavelet transformation converts continuous signal to discrete one. Discrete wavelet transform for which the wavelets are sampled at discrete intervals.DWT has become a emerging tool for image/audio, data processing and compression. DWT aims at efficient time-frequency representation of signal. DWT provides simultaneous spatial and frequency domain information of the image. In DWT operation, an image can be analyzed by the combination of analysis filter bank and decimation operation. The analysis filter bank consists of a pair of low and high pass filters corresponding to each decomposition level. The low pass filter extracts the approximate information of the image whereas the high pass filter extracts the details such as edges. The 2D transform is obtained from two separate 1D transforms. The implementation of wavelet transform is very similar to that of sub band coding scheme as shown in figure 3

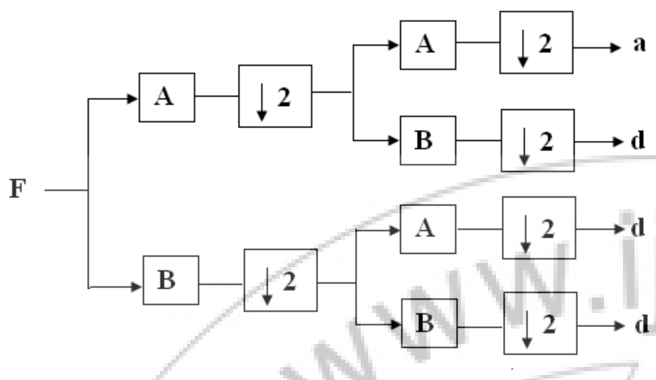

Figure 3: Wavelet Transform Sub-band Coding

We can illustrate working of wavelets with a simple example. Assume we have a 1D image with a resolution of four pixels, having values [9 7 3 5]. We can represent this image using wavelet transform by applying wavelet. Suppose Haar wavelet basis is used to represent this image .To do this, first average the pixels together, pair wise, is calculated to get the new lower resolution image with pixel values [8 4]. Clearly, in this averaging process some information is lost. We need to store some detail coefficients to recover the original four pixel values from the two averaged values. In our example, 1 is chosen for the first detail coefficient, since the average computed is 1 less than 9 and 1 more than 7. This single number is used to recover the first two pixels of our original four-pixel image. Similarly, the second detail coefficient is -1, since 4 + (-1) = 3 and 4 - (-1) =5. Thus, the original image is decomposed into a lower resolution (two-pixel) version and a pair of detail coefficients [3]Repeating this process recursively on the averages gives the full decomposition of image as shown in table 1.

Table 1: Decomposition to lower resolution

Resolution	*Averages*	*Detail Coefficients*
4	[9 7 3 5]	
2	[8 4]	[1 -1]
1	[6]	[2]

Proposed method performs multilevel decomposition of edge tracked image. Approximation coefficients resulting from multilevel wavelet transform are fused together. These approximation coefficients are as shown in figure4. Fused approximation coefficients gives face feature vector

Figure 4: Edge detected multiscale approximation sub-band images

4. Feature Classification

Objective of pattern recognition system is to design a robust recognition system which will classify unknown patterns with the lowest possible probability of false recognition. Distant classifier is simplest and popular approach for pattern recognition. Distances between feature space of gallery and probe image representations are used as the basis for recognition decision. City block based distance classifier is used for matching of face image templates. The matching score is calculated through the calculation between two final fused wavelet coefficients. City block Distance classifier algorithm gives dissimilarity measure between the two face feature wavelet coefficients. The result of the measure is then compared with an experimental threshold to decide whether or not the two representations belong to the same user. The distance between the vectors of two images is the similarity of the images.

5. Discussion of the Proposed FR systems and Experimental Results

5.1 ORL

The ORL database (ORL Database 1992) of faces is composed of 400 grayscale images of size 112×92 pixels corresponding to 40 distinct individuals [16]. It consists of 10 images of each individual taken in various sessions varying the lighting, facial expressions (open/ closed eyes, smiling/ not smiling) and facial details (glasses/ no glasses); taken against a dark homogeneous background in an upright, frontal position (with tolerance for some side movement).

Figure 5: Faces from the ORL Database

5.2 JAFFE

JAFFE database consist of 213 images of 7 facial expressions (6 basic facial expressions + 1 neutral) posed by 10 Japanese female subjects [17]. Each image has been rated on 6 emotion adjectives by 60 Japanese subjects.

Figure 6: One female from the JAFFE Database

5.3 Indian Face Database

This database [18] contains a set of 11 different face images of 40 male and female subjects taken in February, 2002 in the IIT Kanpur campus. All the images were taken against a bright homogeneous background with the subjects in an upright, frontal position. The size of each image is 640x480 pixels, with 256 grey levels per pixel. The following orientations of the face are included: looking front, looking left, looking right, looking up, looking up towards left, looking up towards right, looking down. Available emotions are: neutral, smile, laughter, sad/disgust.IIT Female face database has been used for evaluation of proposed algorithm.

Figure 7: One subject from Indian face database

5.3 Experimental Results

Proposed face recognition system has been evaluated on standard databases ORL, JAFFE, Indian Face database. Result of proposed edge tracking based face recognition system is shown in table 2.

Table 2: Results on expression, illumination and Pose invariant face recognition

Database	*No. of training images*	*No. of testing images*	*Recognition Accuracy*
ORL	6	4	95%
JAFFE	6	9	98.88%
IIT Female	7	4	84.52%

6. Conclusion

In this paper, we have proposed a novel multi-scale edge based approach of discrete wavelet transform face feature representation for human face recognition. This paper has also evaluated the performances of the edge based approach in terms of normal and changes in illumination, perspective and facial expressions faces of Jaffe Indian face dataset and ORL datasets The principle contributor for higher accuracy in the proposed face identification systems has been edge detection technique which has played an important role in removing unwanted background part of image. The experimental results show that the proposed algorithm has performed well under the extreme illumination variation, pose and expression variation. In our approach, structural information is represented in terms of wavelet coefficients. using dual tree complex wavelet transform. The recognition is done on the basis of city block distance classifier. The experimental results show that the proposed algorithm has achieved maximum accuracy of 98.88% on expression variation of subset of JAFFE database. Also we have got good results on ORL database and Indian face database with different orientations. Proposed method allows for significant reduction in dimensions of feature vector by the application of edge tracking and DWT to face images. During this evaluation it has been observed that as face images with wide variety of illumination, facial expression and pose variations, lightning conditions, ageing, disguises such as slight cut, glasses or makeup in nature places limitation on performance of system. In the future face Recognition system performance can be excelled by using other feature classification methods. Other biometric features can be combined with face features to boost system's recognition rate and to decrease its error rate.

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