An automatic facial expression, pose and Illumination Analysis

I.T Kazi

***Abstract*-- Face recognition is challenging because it is a real world problem. The human face is complex, natural, object that tends not to have easily identified ages and features. Face recognition difficult scenarios are pose variation, illumination condition, images taken years apart glasses, moustaches, beards and different facial expression(Open mouth, close mouth, open and close eyes variation in eyebrows etc).**

Existing computerized human face recognition has been used to identify one or more persons from still images or video image sequence of a seen by comparing input images with face stored in a database. In this proposed system it is a biometric system that employs automated methods to verify or recognized the identity of a living person across or based on his/her facial expression different poses of image and incident illumination.

I. INTRODUCTION

IN this system I will discuss different methods of face recognition [2, 3, and 8] with their advantages and disadvantages.

Current systems work very well whenever the task image to be recognized is captured under condition similar to those of the training images. However, they are not robust enough if there is variation between task and training images [14].

The task is difficult because the appearance of the face is dramatically altered by variations in illuminations, facial expression, head pose image size and quality facial hair cosmetics, accessories (such as eye glass) and age. To further compound the problem we are often given only a few images of an individual from which to learn the distinguishing features and then asked to recognize him in all possible situations.

The automated methods of facial recognition, even though work very well, do not recognize subject in the same manner as a human brain. The way we interact with other people is firmly based on our ability to recognize them.

One of the main aspects of face identification is its robustness.

Robust face recognition scheme require both low dimensional feature representation for data compression

purpose and enhances discrimination abilities for subsequent image retrieval.

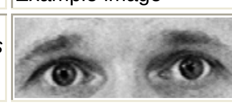
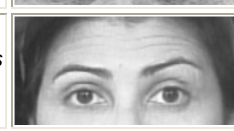
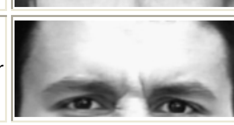
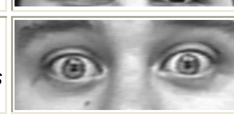
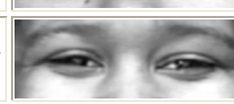
Five steps to facial recognition

1. capture image
2. Find face in the image
3. Extract features (To generate templates)
4. Compare templates
5. Declare matches

Multiple messages in verbal communication corresponding to the several sources of expressive information in the face are many non verbal communication messages that the face can provide some of there messages are validly related to characteristics of the person behind the face, some are fabrication of the viewer unrelated to the real person and other lies somewhere between these two extremes.

II. FACIAL EXPRESSION RECOGNITION TECHNIQUES

An approach to the analysis and representation of facial dynamics for recognition of facial expression from image sequences is presented the algorithms utilize optical slow computation to identify the direction of rigid and non rigid motions that are caused by human facial expressions a mid level symbolic representation motivated by psychological consideration is developed. Recognition of 6 facial expressions, as well as eye blinking is demonstrated on a large set of image sequences.

Description	Facial muscle	Example image
Inner Brow Raiser	*Frontalis, pars medialis*	
Outer Brow Raiser	*Frontalis, pars lateralis*	
Brow Lowerer	*Corrugator supercilii, Depressor supercilii*	
Upper Lid Raiser	*Levator palpebrae superioris*	
Cheek Raiser	*Orbicularis oculi, pars orbitalis*	

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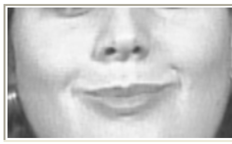
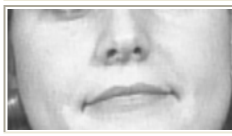
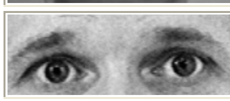
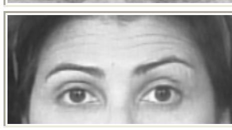
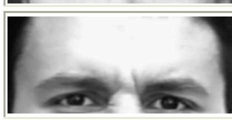
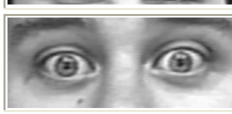
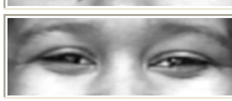
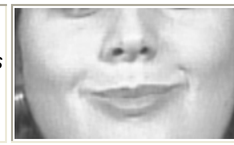
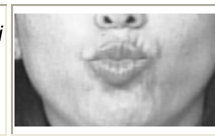
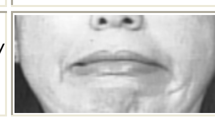
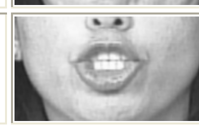
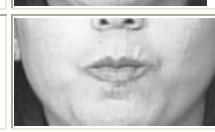
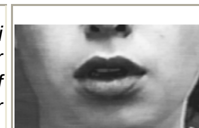
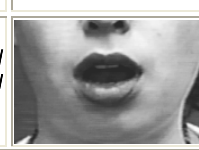
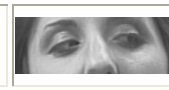
Lid Tightener	*Orbicularis oculi, pars palpebralis*	
Nose Wrinkler	*Levator labii superioris alaquae nasi*	
Upper Lip Raiser	*Levator labii superioris*	
Nasolabial Deepener	*Zygomaticus minor*	
Lip Corner Puller	*Zygomaticus major*	
Cheek Puffer	*Levator anguli oris (a.k.a. Caninus)*	
Dimpler	*Buccinator*	
Lip Corner Depressor	*Depressor anguli oris (a.k.a. Triangularis)*	
Inner Brow Raiser	*Frontalis, pars medialis*	
Outer Brow Raiser	*Frontalis, pars lateralis*	
Brow Lowerer	*Corrugator supercilii, Depressor supercilii*	
Upper Lid Raiser	*Levator palpebrae superioris*	
Cheek Raiser	*Orbicularis oculi, pars orbitalis*	
Lid Tightener	*Orbicularis oculi, pars palpebralis*	
Nose Wrinkler	*Levator labii superioris alaquae nasi*	

Upper Lip Raiser	*Levator labii superioris*	
Nasolabial Deepener	*Zygomaticus minor*	
Lip Corner Puller	*Zygomaticus major*	
Cheek Puffer	*Levator anguli oris (a.k.a. Caninus)*	
Dimpler	*Buccinator*	
Lip Corner Depressor	*Depressor anguli oris (a.k.a. Triangularis)*	
Chin Raiser	*Mentalis*	
Lip Puckerer	*Incisivii labii superioris and Incisivii labii inferioris*	
Lip stretcher	*Risorius w/ platysma*	
Lip Funneler	*Orbicularis oris*	
Lip Tightener	*Orbicularis oris*	
Lips part**	*Depressor labii inferioris or relaxation of Mentalis, or Orbicularis oris*	
Jaw Drop	*Masseter, relaxed Temporalis and internal Pterygoid*	

Mouth Stretch	*Pterygoids, Digastric*	
Lip Suck	*Orbicularis oris*	
Lid droop**	*Relaxation of Levator palpebrae superioris*	
Slit	*Orbicularis oculi*	
Eyes Closed	*Relaxation of Levator palpebrae superioris; Orbicularis oculi, pars palpebralis*	
Squint	*Orbicularis oculi, pars palpebralis*	
Head turn left		
Head turn right		
Head tilt left		
Head tilt right		
Head forward		
Head back		
Eyes turn left		

III. FACIAL EXPRESSION RECOGNITION THAT ALLOWS FACE MOTION IN DEPTH

The recognition problem under an unknown motion in depth of the face is difficult because the view points associated with the candidate image and modal (reference) image data could be very different making it hard to match the model data directly with the candidate image. We explore a solution that given a candidate image to recognize, first synthesizes from the model data (two or more images) a novel view that is under a view point as recognition template to compare with the given image.The solution assumes that the imaging process could be well approximated as an affine transformation. Experimental results are on real image dta.A facial expression recognition approach based on vector machine tree.

A. Face recognition across illumination

There are two important lessons that may be learned

1) There is no single feature or set of features that are truly invariant to all the variations mentioned above. Something that is invariant to Illumination, for instance is no longer invariant When pose is also changed.

2) Given more training images almost any classification method perform better (smaller misclassification error) but in many applications few training images are available. The key idea then ,is to artificially generate moer training images from the initial few this enlarged Set of training data ,we learn an exemplar based classifier. Intuitively, we can render all kinds of variations for each person. All combinations of pose, illumination, expression etc if we do had captured images of the person under all possible variations.

We demonstrate this idea by rendering faces under novel illumination and show that it does Indeed allow our classifier to cope with lighting changes . Few of recognition methods reported in the literature are capable of recognizing faces under varying Illumination condition. One of the method which can achieve a higher recognition rate than those obtained for existing methods .the novelty of this new method is the use of an embossing techniques to process a face image before presenting it to a standard face.

B. Face recognition across pose

The pose problem is a difficult area of face recognition. Until now, we haven't had a good method to tackle the problem. In this paper a simply frontal parallel face recovery method is presented ,the method is simple and effective ,it addresses the computationally expensive problem of current 3-D model pose recovery methods .this method can greatly enhance the recognition rate.

In many face recognition tasks the pose of the probe and gallery images are different .In other cases multiple gallery or probe images may be available each captured from a different pose. One of the face recognition algorithm which can use any number of gallery images per subject Captured at arbitrary poses, any number of probe images ,again captured at arbitrary poses.

IV. FACE RECOGNITION TECHNIQUE A COMPARATIVE STUDYING

There are different method of face recognition are present namely principal component analysis ,Discrete wavelet transform cascade with PCA Template matching ,discrete wavelet transform, histogram segmentation etc.

A. Segmentation/Detection

The first step in any automatic face recognition Systems is the detection (segmentation) of faces in Images. Up to the mid-1990s, most work on Segmentation was focused on single-face Segmentation from a simple or complex background. These approaches included using a whole- face template, a deformable feature-based template, skin, color, and a neural network. Significant advances have been made in recent years in achieving automatic face detection under various conditions [2,3]. Compared to feature-based methods and template-matching methods, appearance or image based methods that train machine systems on large numbers of samples have achieved the best results. More recently, detection of faces under rotation in depth has been studied. One approach is based on training on multiple view samples.

B. Feature Extraction Methods:

The importance of facial features for face recognition cannot be overstated. Many face recognition systems need facial features in addition to the holistic face. Three types of feature extraction methods can be distinguished: (1) generic methods based on edges, lines, and curves; (2) feature-template-based methods that are used to detect facial features such as eyes; (3) structural matching methods that take into consideration geometrical constraints on the features. Early approaches focused on individual features; for example, a template-based approach was described in to detect and recognize the human eye in a frontal face. These methods have difficulty when the appearances of the features change significantly, for example, closed eyes, eyes with glasses, open mouth.

To detect the features more reliably, recent approaches have used structural matching methods, for example, the Active Shape Model. Compared to earlier methods, these recent statistical methods are much more robust in terms of handling variations in image intensity and feature shape. An even more Challenging situation for feature extraction is feature "Restoration," which tries to recover features that are Invisible due to large variations in head pose. The best solution here might be to hallucinate the missing features by either using the bilateral symmetry of the face or using learned information. For example, a view-based statistical method claims to be able to handle even profile views in which many local features are invisible.

C. Recognition from Intensity Images:

Different methods have been proposed over the last few decades. In literature these methods are classified into three main categories: holistic matching methods, Feature-based matching methods and hybrid methods.

Holistic matching methods use the whole face region as the raw input to a recognition system. One of the most widely used representations of the face region is eigen pictures [12,13], which are based on Principal Component Analysis (PCA).). Using PCA, many face recognition techniques have been developed: eigenfaces, which use a nearest neighbor classifier; feature-line- based methods, which replace the point-to-point distance with the distance between a point and the feature line linking two stored sample points; Fisher faces which use linear/ Fisher discriminant analysis (FLD/LDA); Bayesian methods, which use a probabilistic distance metric; and SVM methods, which use a support vector machine as the classifier.

Utilizing higher order statistics, independent-component analysis (ICA) is argued to have more representative power than PCA, and hence

may provide better recognition performance than PCA. Being able to offer potentially greater generalization through learning, neural networks/learning methods have also been applied to face recognition. One example is the Probabilistic Decision-Based Neural Network (PDBNN) method and the other is the evolution pursuit (EP) method.

Typically in Feature-based matching methods, local features such as the eyes, nose, and mouth are first extracted and their locations and local statistics (geometric and/or appearance) are fed into a structural classifier. Most earlier methods belong to the Feature-based matching methods, using the width of the head, the distances between the eyes and from the eyes to the mouth, etc, or the distances and angles between eye corners, mouth extrema, nostrils, and chin top. More recently, a mixture-distance based approach using manually extracted distances was reported. Without finding the exact locations of facial features, Hidden Markov Model (HMM) based methods use strips of pixels that cover the forehead, eye, nose, mouth, and chin reported better performance than by using the KL projection coefficients instead of the strips of raw pixels One of the most successful systems in this category is the graph matching system, which is based on the Dynamic Link Architecture (DLA) Using an unsupervised learning method based on a self-organizing map (SOM), a system based on a conventional neural network (CNN) has been developed. Hybrid methods are based on using both local features and the whole face region to recognize a face, as the human perception system uses. One can argue that these methods could potentially offer the best of the two types of methods.

V. STRENGTHS OF EFFICIENT FACE RECOGNITION METHODS:

In this paper we will discuss four different methods namely principal component analysis(PCA), PCA+DWT,Contour Matching, Isodensity Line Maps cascaded with Hopfield Neural Network with their advantages ,algorithms and analysis.

The PC A method is a low dimensional procedure for the characterization of human faces based on Principal Component Analysis (PCA) also known as Karhunen-Loeve (K-L) or eigenspace, seeks the direction in the input space along which most of the image variations lies. This approach reduces the dimension size of an image greatly. [4, 9, 12, 13, 16, 21]. : As % recognition using PCA is low. We propose a system in which we first find out Discrete Wavelet Transform of a given image and then cascaded with PCA. In the proposed algorithm we have cascaded DWT with PCA. Some of the advantages of wavelet transformations are to preserve the structure of data, computation complexity (space complexity is linear), vanishing moments (where noisy data can be eliminated), compact support

(processing the data inside the wavelet region without affecting the data outside its region), and decreased coefficients (used to reduce complex process in time

domain to simple process in wavelet domain). DWT is analogues to Human Visual System. Wavelets are an efficient and practical way to represent edge and image information at multiple spatial levels [15,18].

The Contour Matching method has advantages in storage space requirements. For matching purposes, storage of the whole registered picture is not required. Only the contours extracted from a face need be stored. Since the lines are made of binary pixels, the corresponding gray level information does not have to be stored. It is estimated that the storage requirement can be decreased substantionally. Since only simple template matching is used, a parallel architecture can speed up the whole process.[6,20]. The advantage of Isodensity Line Maps cascaded with

VI. ALGORITHM OF VARIOUS METHODS

A. *Algorithm of PCA Method*

The algorithm for the facial recognition in spatial domain using eigenfaces is described in figure 1. The original images of the training set are transformed into a set of eigenspaces E. Afterwards the weights are calculated for each image of the training set and stored in the set W. For an unknown image X, the weights are calculated for that image and stored in the vector Wx. The Wx is compared with the weights of the training set W. It is compared using distance measures, which is calculated using Euclidean distance. If this average distance exceeds some threshold value θ, then the weight vector of the unknown image Wx lies too far apart from the weights of the faces. In this case, the unknown X is considered to be not a face. Otherwise if X is actually a face, its weight vector Wx is stored for later classification. The optimal threshold value θ is determined empirically.

B. *Algorithm of DWT+PCA approach [18] :*

We use term Wavelet PCA to refer to computing principle components for a masked or modified set of wavelet coefficient to find Wavelet PCA eigenspectra in spectral domain and then projecting the original image onto the wavelet PCA eigenspectra basis. In this way, features at a particular scale are indirectly emphasized by the computed projection basis enhancing the reduced dimensionality images without filtering artifacts.

C. *Algorithm for Calculation Of DWT Of A Given Image:*

The Square Two-Dimensional DWT is calculated using a series of one dimensional DWTs which is as follows: [7,8]

Step 1: Replace each image row with its 1D DWT

Step 2: Replace each image column with its 1D DWT

Step 3: Repeat steps (1) and (2) on the lowest sub-band to create the next scale

Step 4: Repeat step (3) until the desired number of scales has been created

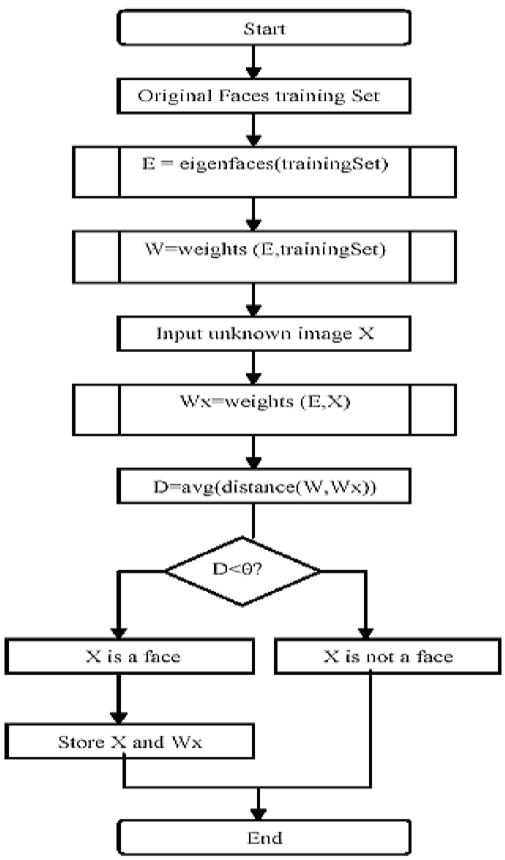


Figure 1: High-level functioning principle of the eigen face-based facial recognition algorithm

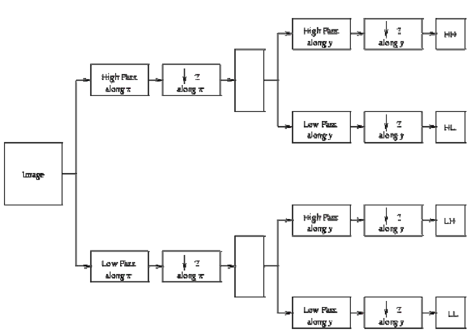


Figure2: forward DWT

Figure 3 shows one level decomposition of a given image. Figure3 (a) shows input image which of the size 64×64. Figure 3(b) shows frequency bands of DWT. Figure 3 (c) shows DWT image of a given image.

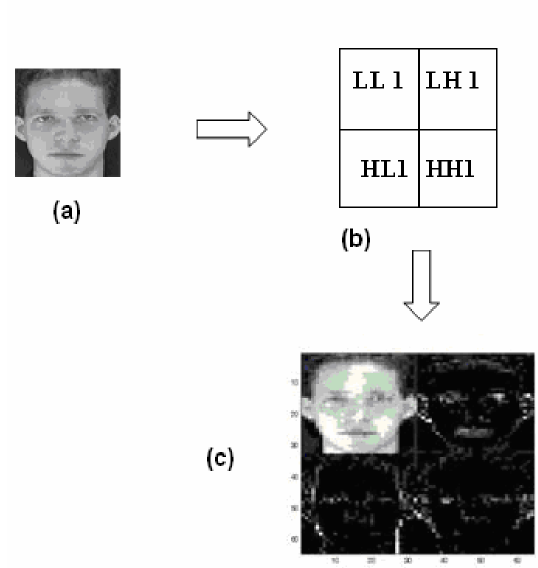


Figure 3. : One level decomposition (a) Input image(b) Frequency bands (c) DWT image

VII. CONTOUR MATCHING METHOD [20]

The proposed face system recognition is a three step process i.e.) 1)Preprocessing and normalization.

2) Contour Generation.

3) Matching Algorithm.

A. *Contour Generation*

This is the core of the project in which the contour of the face is generated from the image. The whole face is treated as a contour map, with the areas of "constant gray-level brightness" (i.e. the plains) enclosed by the contour lines. Thus contour for a given face can be generated. Figure 4 shows contour of a given image

B. *Matching*

In general, it is quite difficult to extract facial area information using only simple techniques. In two face images of the same person, similar features can still be found in their contours. On the contrary, there are remarkable differences, not only in the shape but also in the size of the contours for images of different persons Hence, identification is done using the matching of contours of two faces. The picture which is to be matched is called the input picture, and the picture it has to be matched to is called the registered picture. Only simple template matching has been adopted from the practical point of view

C. *Data preparation*

We have used BioId database[7] and ORL database [14] as our test bed to compare algorithm. The frontal face images of the 20 subjects in BioId database each with 5 different expression provide variation in views of the individual ects in ORL database each with 10 different expression provide variation in views of the individual such as lighting, facial features (such as glasses) and slight changes in head orientation are used for evaluation.. such as lighting, facial features (such as glasses) and slight changes in head orientation. and the frontal face images of the 20 subj

D. Result Analysis of PCA Method

We have taken image of the size 92×112 Performance evaluation of proposed algorithm on different databases is given in table-1. recognition rate ,train time per model, test time per image. Series1 gives % recognition rate, series 2 gives train time per model ,series3 gives test time per model. From the graph as number of eigen values goes on increasing the recognition rate is also goes on increasing. But computational time goes on increasing. Also an investigation is made into the recognition rate at different resolution using ORL database. The results of the findings are given in table2.

TABLE 1:PERFORMANCE EVALUTION OF PCA ALGORITHM[21]

Sr No	Parameters	BioID Database	ORL Database
1	No of subjects	20	20
2	No of different expressions per	05	10
3	Total no of images	100	200
4	Recognition Rate	95 %	80 %
5	False Acceptance	Nil	Nil
6	False Rejection Rate	5 %	20 %

VIII. RESULT ANALYSIS OF DWT+ PCA METHOD:

First we have scaled the image from 92□ 112 to 64□ 64. Then DWT of 64□ 64 image is taken and then eigen space is generated.

TABLE 2
RESULTS OF RECOGNITION AT DIFFERENT RESOLUTIONS FOR THE PROPOSED PCA BASED ON FACE RECOGNITION SCHEME ON ORL DATABASE [21].

Image Size	% Recognition Rate	Train Time per Model	Test Time per Image
92×112	80	6.52sec	2.79sec
64×64	93	6.33 sec	2.35 sec

Performance evaluation of proposed algorithm of DWT+PCA with PCA method on ORL databases is given in table-3.

TABLE 3
PERFORMANCE OF DWT+PCA WITH PCA ALGORITHM ON ORL DATABASE [18]

Sr No	Parameters	DWT+PCA	PCA
1	No of subjects	20	20
2	No of different expressions per subjects	10	10
3	Total no of images	200	200
4	Recognition Rate	89.5 %	80 %
5	False Acceptance Rate	Nil	Nil
6	False Rejection Rate	10.5%	20%

The recognition rate is dependent to the selected wavelet function and the level of decomposition. Authentication is given. If the Final matching ratio is greater than threshold then the user is authenticated. In our case wehave taken threshold value is 0.1990 which was determined by experimental means. Performance evaluation of proposed algorithm on BioID databases is given in table-4. As number of training images increases the recognition rate goes on increasing.

TABLE 4
PERFORMANCE EVALUATION OF CONTOURING MATCHING ALGORITHM [20]

Sr No	Parameters	BioID Database
	No of subjects	15
2	No of different Expressions per subjects	05
3	Total no of images	75
4	Recognition Rate	100 %
5	False Acceptance Rate	Nil
6	False Rejection Rate	Nil

Result Analysis of Contour Matching Method:

Based on the contour comparison the result of the user

IX. SUMMARY

The face similarity meter was found to perform satisfactorily in constrained conditions of exposure, illumination and contrast variations.

In contour matching though recognition rate is very high but recognition time per image is very high. .In contour matching though recognition rate is very high but recognition time per image is very high.

1.) To rescale the energy function in Hopfield network to avoid the spurious states and improve the recognition rate.

2.) Use neuro fuzzy approach to improve recognition rate. Though some problems are still to be experimented (such as effect of a more tilting of the head etc) and the algorithm needs to be tested for large variations of pose The proposed system of face recognition may be applied in identification systems, document control and access control. Biometric technologies are found application in four road application categories: surveillance, screening, enrollment identification, entity verification. General security tasks, such as access control to buildings, can be complished by a face recognition system. Banking operations and credit card transactions could also be verified by matching the image encoded in the magnetic strip of the card with the person using the card at any time. Finally, a robust system could be used to index video-documents (video- mail messages, for example) and image archives. An image archive indexed in such a way would be useful for criminal identification by the investigation department.

X. REFERENCES

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