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Facial Feature Expression Based Approach for Human Face Recognition: A Review

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Abstract: The extraction of required facial expression features from the human face image is an important task for face recognition. Facial expressions are natural means of communications between humans and play a major role in pattern recognition and image processing. Research in facial expression recognition has considered seven basic facial expressions namely anger, disgust, fear, happy, sad, surprise and neutral. For the face expression recognition three main phases are used: face detection, facial feature extraction and facial feature classification and recognition. In this paper we studied the different facial feature recognition techniques proposed by various researchers: Gabor, DWT, DCT, RSST Segmentation and Local Binary Patterns(LBP) features with their advantages and disadvantages.

Index Terms: Facial Expression Recognition, Gabor filter, Discrete Wavelet Transform, Discrete Cosine Transform, Recursive Shortest Spanning Tree **(**RSST) segmentation, Local Binary Patterns.

I. INTRODUCTION

Facial expression plays a principal role in human interaction and communication since it contains critical information regarding emotion analysis. Its applications include human–computer interface, human emotion analysis, and medical care and cure. The task of automatically recognizing different facial expressions in human–computer environment is significant and challenging. Due to its wide range of applications, automatic facial expression recognition has attracted much attention in recent years [1-4].

From the start of the day there are plenty of emotions till the end, hence the emotions play a key role in decision making [5]. The emotion is recognized by only with the help of expressions. The person can recognize the expressions by seeing directly them because every emotion has its own expression but person to person a little bit of variation may exist. The system which implements the recognition of the human facial expressions is called facial recognition system. The facial emotion recognition system involves in the following steps are Face Detection, Face Recognition, Face Emotion Recognition system.

An effective facial representation from original face images is a vital step for successful facial expression recognition. There are two common approaches to extract facial features: geometric feature-based methods and appearance-based methods [1]. Geometric features present the shape and locations of facial components, which are extracted to form a feature vector that represents the face geometry. Recently Valstar et al. [6,7] have demonstrated that geometric feature-based methods provide similar or better performance than appearance-based approaches in Action Unit recognition. With appearance-based methods, image filters, such as Gabor wavelets, are applied to either the whole-face or specific face-regions.

The paper is organized as follows. In section 2, Face detection and recognition is described. Starting with a brief description of Facial Expression Recognition and Feature extraction in section 3 and 4, Gabor Filter, Discrete Wavelet Transform, DCT, RSST segmentation and LBP with Template matching and SVM are described in sections 4.1, 4.2, 4.3, 4.4 and 4.5 respectively. Some conclusions and future work are then given in section 5.

II. FACE DETECTION AND RECOGNITION

A. Face Detection:

The purpose of extracting the face region from the background means face detection. Face detection from images is a key problem and a necessary first step in face recognition systems. The several applications such as content-based image retrieval, video coding, video conferencing, crowd surveillance, and intelligent human-computer interfaces.

Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually one). In face detection, one does not have this additional information.

Early face-detection algorithms focused on the detection of frontal human faces, whereas newer algorithms attempt to solve the more general and difficult problem of multi-view face detection [8]. This means that the detection of faces that are either rotated along the axis from the face to the observer (in-plan rotation), or rotated along the vertical or left-right axis (out-of-plane rotation), or both. The newer algorithms take into account variations in the image or video by factors such as face appearance, lighting, and pose. Face detection is used in biometrics, often as a part of a facial recognition system.

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Fig: 1 Face Detection

B. Face Recognition:

Face recognition system is computer application that automatically identifying or verifying a person from a digital image by comparing selected facial features from the image and a facial database. The accuracy of face recognition depends on how well the input images have been compensated for illumination, pose and facial expression. The variations of facial appearances caused by illumination. The appearances are classified into four main components: diffuse reflection, specular reflection, attached shadow and cast shadow [9]. Variations among images of the same face due to illumination and viewing direction are almost always larger than image variations due to change in face identity.

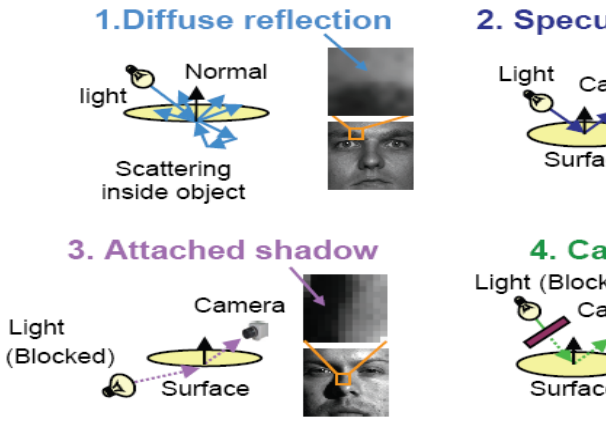

Fig: 2 Face Recognition

III. FACIAL EXPRESSION RECOGNITION

Facial expression is one of the most powerful and immediate means for humans to communicate their emotions, cognitive processes, intentions, physical efforts or other intra or interpersonal meanings [10].

The general approach to facial expression recognition consists of five steps [11].

1. **Image acquisition:** Images used for facial expression recognition are static images and image sequences. Ideally a face acquisition stage features on automatic face detector that allows locating faces in complex scenes with cluttered background.
2. **Preprocessing:** Image preprocessing often takes the form of signal conditioning together with segmentation, location or tracking of the face or its parts.
3. **Feature Extraction:** Feature Extraction methods can be categorized according to whether they focus on motion or deformation of faces and facial features, respectively.
4. **Classification:** Expression categorization is performed by classifiers. Covering parametric as well as non-parametric techniques has been applied to the automatic expression recognition problem.
5. **Postprocessing:** It aims to improve recognition accuracy by exploiting domain knowledge to correct classification errors.

Some examples of feelings are; 1) Anger 2) Fear 3) Joy 4) Disgust 5) Sad 6) Surprise and 7) Neutral.

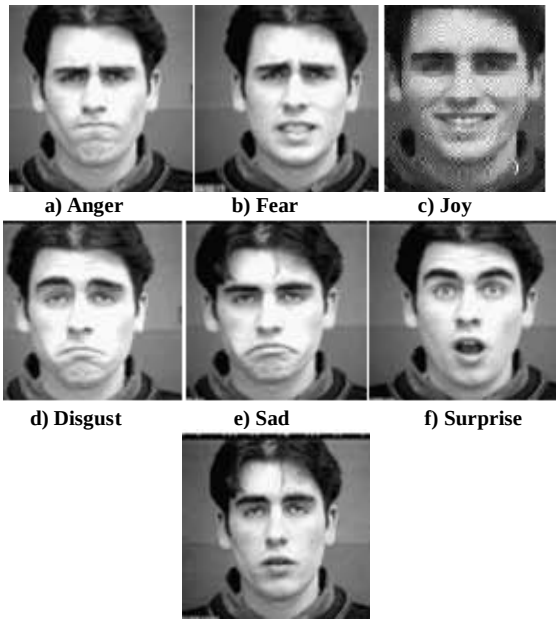

Fig. 3 Sample of face expressions

IV. FACIAL FEATURE EXTRACTION TECHNIQUES

There are two methods to extract the features Geometric feature extraction method and non geometric feature extraction method. In geometric method the parts of the image is consider for feature extraction such as mouth, eyes and nose and in the non geometric feature extraction method whole image is consider for feature extraction.

A. Gabor Filter:

Gabor Filters applied to images to extract features aligned at particular orientations or angles. It possess optimal localization properties in both spatial and frequency domains and they have been successfully used in many pattern recognition applications [12]. Gabor Filter bank can capture the relevant frequency spectrum in all directions. Gabor Filter is a complex exponential

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modulated by a Gaussian function in the spatial domain [13]. The equation of Gabor Filter can be represented as:

$$\Psi(x, y, \lambda, \theta) = \frac{1}{2\Pi S_x S_y} e^{-1/2\left(\frac{x'^2}{S_x \cdot S_x} + \frac{y'^2}{S_y \cdot S_y}\right)} e^{j2\Pi x'/\lambda}$$

where (x, y) is the pixel position in the spatial domain, λ is the wavelength (a reciprocal of frequency) in pixels, θ is the orientation of a Gabor Filter, and Sx, Sy are the standard deviation along the x and y directions respectively. The parameters x' and y' are given as

x' = xcosθ + ysinθ and y' = - xcosθ + ysinθ

The advantage of a Gabor filter are concentration on important components of face such as mouth, eyes, nose, etc. Gabor features are invariance to illumination, rotation, scale and transform and have optimal localization property in frequency and spatial domain. But the disadvantage is not to represent face global structure and face texture. The dimension of feature vector obtained from Gabor Filter is very huge so the time for performing Gabor Filter feature extraction is very high. Gabor Filters are not optimal when objective is to achieve broad spectral information with maximum spatial localization.

B. Discrete Wavelet Transform:

Wavelet Transform gives both the spatial and frequency information of the images. The signal is cut into several parts and each part is analyzed separately in the frequency representation. The Commonly used discrete wavelets are daubechies wavelets [14]. Wavelets with one level decomposition is performed by using the high pass filter 'g' and the low pass filter 'h'. Convolution with the low pass filter gives the approximation information while convolution with the high pass filter leads to the detail information [15]. The overall process is modeled in the following equation 1- 4.

$$A = [\, h * [\, h * f\,]\, x \downarrow 2]\, y \downarrow 2 \ldots\ldots\{1\}$$
$$V = [\, h * [\, g * f\,]\, x \downarrow 2]\, y \downarrow 2 \ldots\ldots\{2\}$$
$$H = [\, g * [\, h * f\,]\, x \downarrow 2]\, y \downarrow 2 \ldots\ldots\{3\}$$
$$D = [\, g * [\, g * f\,]\, x \downarrow 2]\, y \downarrow 2 \ldots\ldots\{4\}$$

The '*' represents the convolution operation and '↓2' represents the down sampling by 2 along the direction x or y [14]. To correct this sample rate, the down sampling of the filter by 2 is performed (by simply throwing away every second coefficient). The daubechies wavelets have many wavelets functions. In this decomposition A gives the approximation information and the image is a blur image as shown in fig. 4. H gives the horizontal features, V gives the vertical features and D gives the diagonal features present in the image. While compared with remaining three wavelet coefficients, the wavelet coefficient A gives the high performance. Further D gives the less performance. Using the A + H + V + D wavelet coefficients leads to a performance which is nearly equal to the A's performance. So the A's coefficients are used to form the feature vector.

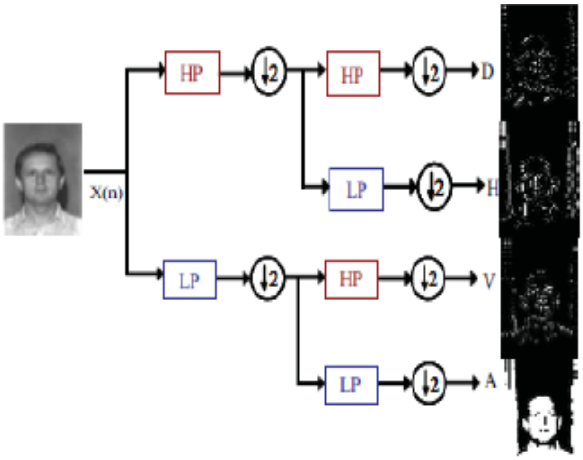

Fig. 4 Discrete Wavelet Transforms

The advantages of DWT have the feature of multiresolution, locality, sparsity, decorrelation. These properties make the wavelet domain of natural image more propitious to feature extraction for face recognition, compared with direct spatial domain. It have the ability to capture localized spatial frequency information of image motivates their use for feature extraction.

C. Discrete Cosine Transform:

The N*N image used in Discrete Cosine Transform (DCT) for feature extraction. From this image we get a 2D coefficient matrix. In this matrix high frequency components are located at the top left corner of the matrix and the low frequency component are located at the bottom right corner of the matrix. The selection static coefficient selection approach is used for the coefficient. In this approach zigzag scanning is used as shown in fig. 5[16].

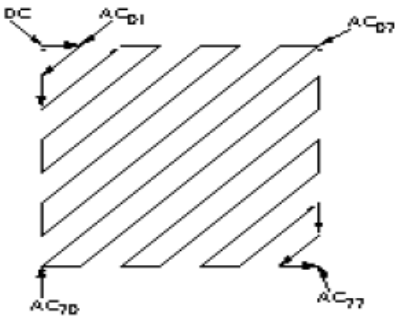

Fig. 5 Discrete Cosine Transform

In the above fig.5 shows two components AC and DC. The AC components represents individual pixel value while DC component represents the whole image.

Discrete Cosine Transform have the properties of decorrelation, energy compaction, orthogonality and separability. The DCT does a better job of concentrating energy in to lower order coefficients. These are the advantages of DCT feature extraction technique. The disadvantage of the DCT feature extraction technique is that the DCT features are sensitive to changes in the illumination direction. In DCT, only spatial co-relation of pixel inside the single 2D-block is considered and co-relation from pixel of neighboring block is neglected and

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the magnitude of the DCT coefficients is not spatially invariant.

D. RSST Segmentation:

A face-bounding box is obtained from the skin map. The Recursive Shortest Spanning Tree **(**RSST) segmentation algorithm is applied for creating a segmentation partition of homogeneous regions. Possible mouth features are first identified based on the redness property of image pixels and the corresponding RSST regions. Eye features are then identified relative to the position of the mouth, by searching for regions which satisfy some statistical, geometrical, and structural properties of the eyes in frontal face images. A general view of a frontal face image containing a mouth and two eyes is shown in fig. 6.

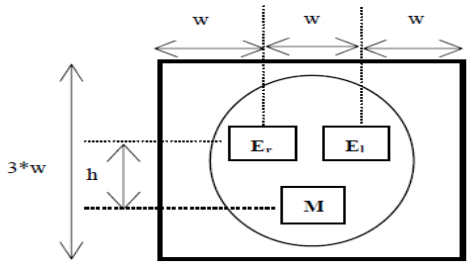

Fig. 6. A frontal face view

E_l and E_r represent left and right eyes respectively, while M represents the mouth feature. The distance between the two eyes is w and the distance from the mouth to the eyes is h. In frontal face images, structural relationships such as the Euclidean distance between the mouth, and the left and right eye, the angle between the eyes and the mouth, provide useful information about the appearance of a face. These structural relationships of the facial features are generally useful to constrain the facial feature detection process [17]. A search area represented by the square of size (3w x 3w) is also an important consideration in order to search for faces based on the detected eye feature positions in the image.

E. Local Binary Patterns (LBP):

The original LBP operator was introduced by Ojala et al. [18], and was proved a powerful means of texture description. The operator labels the pixels of an image by thresholding a 3 x 3 neighborhood of each pixel with the center value and considering the results as a binary number. The 256-bin histogram of the LBP labels computed over a region is used as a texture descriptor. The derived binary numbers called Local Binary Patterns or LBP codes. It codify local primitives including different types of curved edges, spots, flat areas, etc.

Due to its discriminative power and computational simplicity, LBP texture operator [22] has become a popular approach in various applications. It can be seen as a unifying approach to the traditionally divergent statistical and structural models of texture analysis. Perhaps the most important property of the LBP operator in real-world applications is its robustness to monotonic gray-scale changes caused, for example, by illumination variations.

The most important property of the LBP operator in real-world applications is its robustness to monotonic gray-scale changes caused by illumination variations. Another important property is its computational simplicity [23], which makes it possible to analyze images in challenging real-time settings. The drawbacks in this system are it is highly sensitive to glasses and it is time consuming process. To overcome the drawbacks of existing system, a new method is proposed i.e. 2D-PCA (Principal Component Analysis).

The different machine learning techniques, including Template matching, Support Vector Machines, Linear Discriminant Analysis and the linear programming technique, are used to recognize expressions.

1. Template matching

Template matching is used to perform face recognition using the LBP-based [19] facial representation. A template is formed for each class of face images, then a nearest-neighbour classifier is used to match the input image with the closest template.

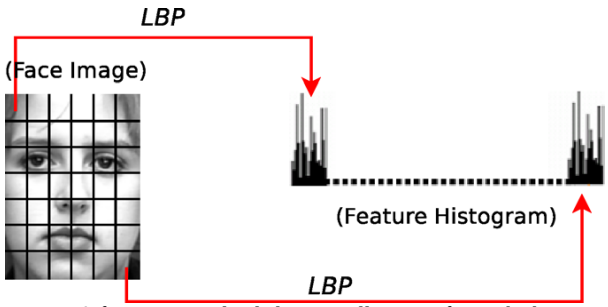

Fig. 7. A face image is divided into small regions from which LBP histograms are extracted and concatenated into a single, spatially enhanced feature histogram.

The Chi square statistic (X^2) also selected as the dissimilarity measure for histograms:

$$\chi^2(\mathbf{S},\mathbf{M}) = \sum_i \frac{(S_i - M_i)^2}{S_i + M_i}$$

where S and M are two LBP histograms. It is observed that some local facial regions contain more useful information for expression classification than others.

2 Support Vector Machine (SVM)

SVM as alternative classifiers for expression recognition. As a powerful machine learning technique for data classification, SVM [20,21] performs an implicit mapping of data into a higher (maybe infinite) dimensional feature space, and then finds a linear separating hyperplane with the maximal margin to separate data in this higher dimensional space.

SVM makes binary decisions, so the multiclass classification here is accomplished by using the one-against-rest technique, which trains binary classifiers to discriminate one expression from all others, and outputs the class with the largest output of binary classification.

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V. CONCLUSION AND FUTURE WORK

In this research paper we studied the Gabor, Wavelet, DCT, RSST segmentation and LBP feature extraction technique with some advantages and disadvantages. We observed that the DCT Feature extraction technique have the higher recognition rate compared to Wavelet Transform and Gabor filter feature extraction techniques[24-26].

Table 1: Result of DCT by Using Adaboost Classifier.

Expression	AN	FE	DI	HA	SA	SU
RR	70	75	65	63	73	80

Table 2: Result of Gabor by using Adaboost classifier.

Expression	AN	FE	DI	HA	SA	SU
RR	60	50	65	55	82	80

Table 3: Result of Wavelet transform by using Adaboost classifier.

Expression	AN	FE	DI	HA	SA	SU
RR	70	25	68	71	71	70

We also presented the frontal face detection using facial features theory. Using a facial feature extraction step prior to performing PCA analysis helps to address two requirements for this system. Firstly, the search for faces does not need to be carried out at every pixel location in the image since a small search space can be obtained using the detected facial feature points. Secondly, the face detection process can be carried out in one cycle over a normalized search space, thereby avoiding the requirement of processing the image at multiple scales. Deriving an effective facial representation from original face images is a vital step for successful facial expression recognition.

In future the work can be extended for feature extraction techniques improving recognition rate either by introducing the new feature extraction technique or using the hybrid approach for the feature extraction for the facial expression recognition.

References

[1] Y. Tian, T. Kanade, J. Cohn, "Handbook of Face Recognition", *Springer, 2005 (Chapter 11. Facial Expression Analysis).*

[2] M. Pantic, L. Rothkrantz, "Automatic analysis of facial expressions: the state of art", *IEEE Transactions on Pattern Analysis and Machine Intelligence 22 (12) (2000) 1424–1445.*

[3] B. Fasel, J. Luettin, "Automatic facial expression analysis: a survey, Pattern Recognition" *36 (2003) 259–275.*

[4] M. Pantic, L. Rothkrantz, "Toward an affect-sensitive multimodal human–computer interaction", *in: Proceeding of the IEEE, vol. 91, 2003, pp. 1370–1390.*

[5] A.S.Georghiades, P. N. Belhumeur, and D. J. Kriegman, "From few to many: Illumination cone models for face recognition under variable lighting and pose," *IEEE Trans. Pattern Anal. Mach. Intell., vol. 23, no. 6, pp. 643–660, Jun. 2001.*

[6] M. Valstar, I. Patras, M. Pantic, "Facial action unit detection using probabilistic actively learned support vector machines on tracked facial point data", *in: IEEE Conference on Computer Vision and Pattern Recognition Workshop, vol. 3, 2005, pp. 76–84.*

[7] M. Valstar, M. Pantic, "Fully automatic facial action unit detection and temporalanalysis", *in: IEEE Conference on Computer Vision and Pattern Recognition.*

[8] R.Basri and D.W. Jacobs,"Lambertian reflectance and linear sub-spaces," *IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no. 2, pp. 218–233, Feb. 2003.*

[9] Bhabatosh Chanda and Dwijest Dutta Majumder, 2002, Digital Image Processing and Analysis.

[10] R.W.Jr. Week,(1996). "Fundamental of Electronic ImageProcessing Bellingham SPIE Press".

[11] C.C.Chibelushi, F.Bourel,"Facial Expression recognition: a brief tutorial overview", *on-line Compendium of computer Vision, 2003.*

[12] Zheng, D., Zhao,Y., Wang, J.,(2004a) "Features Extraction Using A Gabor Filter Family", *Proceedings of the sixth LASTED International conference, Signal and Image processing, Hawaii, USA.*

[13] T. S. Lee, "Image Representation Using 2D Gabor Wavelets", *IEEE Trans. Pattern Analysis and Machine Intelligence, Vol.18,1996, pp.959-97.*

[14] N. Shams, I. Hosseini, M. Sadri, and E. Azarnasab, "Low cost fpga based highly accurate face recognition system using combined wavelets with subspace methods," *pp. 2077–2080, (2006).*

[15] C. C. LIU, D. Q. Dai, and H. Yan, "Local Discriminant Wavelet Packet Coordinates for Face Recognition, " *Journal of Machine learning Research, pp. 1165–1195, May (2007).*

[16] Bin Jiang, Guo-Sheng Yang, Huan-Long Zhang "Comparative Study Of Dimension Reduction And Recognition Algorithms Of DCT And 2d PCA", *Proceeding Of The Seventh International Conference On Machine Learning And Cybernetics, Kunming, Ieee Pp. 407-410,12-15 July 2008.*

[17] Henry A. Rowley, Shumeet Baluja and Takeo Kanade, "Neural Network-Based Face Detection", *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 20, no. 1, pp. 23-38, January 1998.*

[18] T. Ojala, M. Pietikäinen, D. Harwood, A comparative study of texture measures with classification based on featured distribution, Pattern Recognition " *29 (1)(1996) 51–59.*

[19] T. Ahonen, A. Hadid, M. Pietikäinen, "Face recognition with local binary patterns", *in: European Conference on Computer Vision (ECCV), 2004.*

[20] M. Bartlett, G. Littlewort, I. Fasel, R. Movellan, "Real time face detection and facial expression recognition: development and application to human–computer interaction", *in: CVPR Workshop on CVPR for HCI, 2003.*

[21] V.N. Vapnik, "Statistical Learning Theory", *Wiley, New York, 1998.*

[22] A.K.Jain, "Fundamentals of Digital Image Processing.Englewood Cliffs", *NJ: Prentice Hall, 1989.*

[23] D. W. Jacobs, P. N. Belhumeur, and R. Basri, "Comparing images under variable illumination," *in Proc. IEEE Conf. Computer Vision and Pattern Recognition, 1998, pp. 610–617.*

[24] C.Nagaraju, B.Srinu, E. Srinivasa Rao**,** "An efficient Facial Features extraction Technique for Face Recognition system Using Local Binary Patterns**"**, *in International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-6, May 2013.*

[25] Sanjeev Dhawan, Himanshu Dogra, **"Feature Extraction Techniques for Face Recognition"**, *International Journal of Engineering, Business and Enterprise Applications (IJEBEA) Aug-Nov, 2012, pp. 1-4.*

[26] Aruna Bhadu, Rajbala Tokas, Dr. Vijay Kumar, **"Facial Expression Recognition Using DCT, Gabor and Wavelet Feature Extraction Techniques"**, *International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 1, July 2012.*