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A Review Paper on Feature Extraction and General Approaches for Face Recognition

Venus Bansal[1], Dr. Ajay Kumar Singh[2]
[1]*College of Engineering and Technology Mody University of Science and Technology Lakshmangarh, India*
[2]*College of Engineering and Technology Mody University of Science and Technology Lakshmangarh, India*

Abstract*: To recognize a face is itself an important aspect of visual perception. Face recognition is a combination of bottom-up and top-down processing. Many different approaches used in computer vision should parallel the range of ways leading to face recognition by humans, using different sources of observations. Feature extraction can be used for making face recognition more efficient. In this paper, a review of different approaches used for feature extraction techniques and face recognition based on a different method is done.

Keywords: Object Recognition; accuracy; detection; template matching; feature extraction

I. INTRODUCTION

Developing detection and recognition algorithms become a very fascinating study due to its applications within the field of business, security system, person authentication, robotics, advertising, and enforcement. As a result of the development within the effectiveness of information technology distinctive researchers from all over the world have proposed a number of algorithms and techniques which make immense possibilities for outreach into non standard areas such as nanotechnology, criminal identification and many more by taking advantages of the growing application of computer vision [1]. Recognizing a face could be a major challenge encountered in multidimensional visual model analysis. In today's research, researchers try various attempts to work on various features of the face such as spatial geometry information and scope [2]. Currently, because of a lot of cases of different object stealing, security has become a notable issue in [3]. As an outcome, it is necessary to develop more safety protection. By seeing this, face recognition has appeared as a solution to manage many requirements needed to get proof of identification and verification [4]. Biomedical researchers are also providing a high security as compared to other methods of security using fingerprints analysis and iris scan. The face detection and recognition are considered to be high level computer vision task during which various algorithms are to be carried out to attain accuracy. In this field, much amount of work have been done in order to improve face recognition performance [5]. Another different approach is AdaBoost algorithm uses a set of cascaded classifiers, makes the classification accuracy highly improved through extensive studies [6]. Different algorithm has been proposed that transforms the features, color and shape of the face to improve the performance of recognition[7]. Recognition of faces can also be described as labeling problem based on models of known objects. There exists a huge variety of different approaches to recognize a face in [8]. Automatic face annotation is another approach proposed to detect human faces from a picture and allocate their matching human names [9].

Face recognition is the process of identifying or recognizing a face in an input image. Before recognition we have to perform face detection [1]. Face detection identifies whether there is a face or not in an image. It is beneficial in many applications as follows:

A. Face Identification: Used to identify the human face from the given input. Identification is used in criminal records, credit cards and for security models [3].
B. Verification: for this application, we try to match the presented image in of the individual with the data that is already stored in our database. It is used in banking, passports, electoral registration, etc [10].
C. Surveillance in: To monitor the criminals and drug offenders a large no. of CCTVs can be used [6].
D. Smart card: It is used in [8] for master card identity checks mobile app by verifying the online payment either through fingerprints or facial recognition.
E. Healthcare: Patient medication can be tracked and support in pain management procedures [8].

Beside the application object recognition has to face some challenges. The challenges are as follows:

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F. The quality of an image is the bigger challenge faced during recognition [1]. Sometimes the input images are blurred or affected by the surrounding factors like noise and light. Due to poor quality of an image the robustness of the face recognition are reduced.

G. The next challenge faced under illumination conditions [8]. Illumination may change the appearance of an image due to changes in lighting factor which results in affecting the performance of the face recognition system.

H. Another challenge faced is variety in poses of a human face. It is difficult to extract features from the image having different poses of the human face [11].

I. Occlusion is faced with due to the presence of objects like beard, glasses and mustache on the face [8].

To resolve this, different techniques have been applied, but that are still remaining challenges. In this review paper, some proposed algorithms to overcome one of the major challenges.

II. FACE RECOGNITION PROCESS

Face recognition generally consists of four steps in that is face detection, image processing, feature extraction and selection and finally recognition. In this, we discussed feature extraction step in detail. The flow chart for face recognition process is as follows:

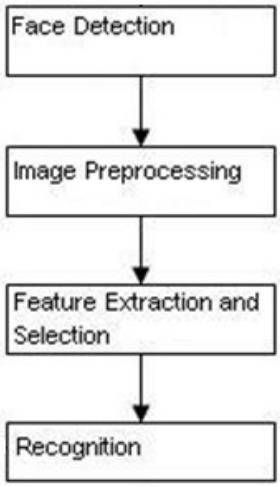

Fig 1. Flow chart for face recognition

Facial feature extraction is the process to represent the facial features of the image as a compact vector by reducing dimensionality. Extracting feature is a vital part of face recognition and it deals with the transformation of data from original data space to a feature space

III. FACIAL FEATURE FOR EXTRACTION

Facial feature extraction in [11] is the process to represent the facial features of the image as a compact vector by reducing dimensionality. Extracting feature is a vital part of face recognition and it deals with the transformation of data from original data space to a feature space.

To perform location based feature extraction, global and grid features is to be extracted [11]. As shown in fig 2. we extract global features like the distance between two eyeballs, eye to chin, eye to lip and eye to nose tip is calculated. Distance is calculated to know the location of the facial features. After extracting global features we have to extract grid features of the human face. Grid features include eyelid region, forehead portion, eye corner and upper portion of the cheeks as shown in fig 3. To calculate grid features, first of all we have to convert the input color image into the grayscale image. Canny edge detection is used to perform on the grayscale image to provide the binary image with wrinkle edges. As we know, in binary images the value 1 is considered to be white pixels and the value is considered as black pixels. The wrinkle pixels of the given image provide the information about the human face for recognition.

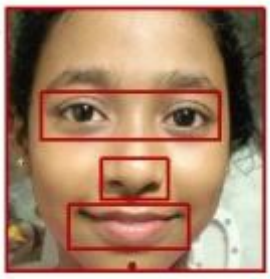

Fig 2. Selected Region of face

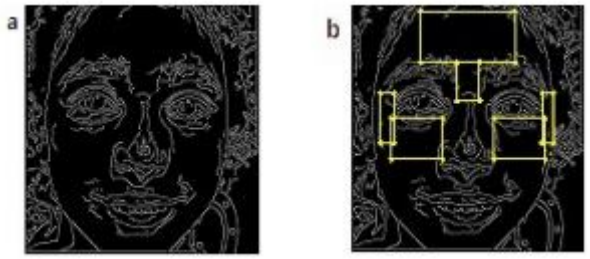

Fig 3. Edge Detected Grid features Extraction

A. Lip Feature

Lip feature may be a sensory organ and lip muscles are particularly deformable, present within the noticeable portion of the external body part and regarded to unique for each human being [12]. Analysis of lip shape and color is used for face recognition. Shi-Tomasi feature corner detection is used to extract this feature.

B. Eye Feature

Eyes plays a vital role to recognize a face [12]. As a result of its small tissues and pleasant facial geometry, it presents unique patterns which make individual human eye completely different from the other human eyes. Template matching is used to extract eye feature. AdaBoost algorithm can also be used to detect an eye.

C. Nose Feature

The nose could be a unique feature of the human face [12]. It additionally stays unaffected even due to changes in facial expressions. The Haar-like cascade features and Adaboost classification algorithmic program is used to find the nose feature.

IV. CLASSIFICATION OF FACE MATCHING METHOD

Various approaches have been discussed to extract these facial features from image to attain high efficiency and accuracy. These are the following basic ways for feature extraction.

A. Geometry Based

This technique uses the size and the relative position of the component of the images to extract the features. Geometry based technique mainly focuses for two purposes. One is to detect the direction and the edges of the component and then making feature vector from the detected components. In doing this we use gradient analysis and canny filter algorithm. For geometry based feature extraction, the Gabor Wavelet Transformation algorithm is used [13]. Using Gabor Wavelet filter we can decompose an image into a texture feature. The frequency and angle are the parameter of Gabor filter is to be considered for feature extraction. Features with similar frequency and angle are to be selected and used to compare facial emotions depicted in an image. A Gabor filter can be represented by the following equation as

$$\psi(x, y, \lambda, \theta) = \frac{1}{2\prod s_x s_y} e^{-\frac{1}{2}\left(\frac{x'^2}{s_x . s_x} + \frac{y'^2}{s_y . s_y}\right)} e^{j2\prod x'/\lambda}$$

(1)

Where (x,y) represents the position of the pixel in the spatial domain, ϴ is the orientation of a Gabor filter, λ is the wavelength, and $s_x s_y$ are the standard deviation.

B. Template Based

Template Matching in is a straightforward process for performing feature extraction for recognition in which we find the smallest part of a digital image that matches the template image [14]. To implement this scheme different image of the templates that containing distinct object are to be stored. It is implemented on both gray and color level pictures. Template matching can be used as quality control, to detect edges and features in an image. In this technique the similarity between the images can be reduced. For template based feature extraction Local Binary Pattern algorithm can be used to recognize a face [15]. LBP works on local facial features of a human face image. LBP is characterized as an order set of binary comparisons of pixel intensities between the center pixels and its eight surrounding pixels. Local Binary pattern operators are used to summarize the local facial feature of a human face image. The equation for LBP as follows:

$$LBP(x_c, y_c) = \sum_{n=0}^{7} s(i_n - i_c)2^n$$

(2)

Where i_c is the valu of the center pixel (x_c , y_c), in is the value of eight surrounding pixels.

C. Appearance Based

This technique is implemented on the basis of appearance based feature extraction. In this technique, The theory of "feature" is completely different from facial features like lips, eyes. Any extracted attribute or characteristics of the image regards to a feature. Based on this appearance technique, various features are applied that split this method into two approaches. One is an appearance technique with local feature and the other is an appearance technique with global features. For locally based we generally used edge detection method and for global we used principal component analysis method. This approach can be useful for 3D object when there is a clustering and occlusion. Due to presence of clustering and occlusion, it has to face challenges which reduces its performance. For appearance based feature extraction Principal Component Analysis algorithm can be used [16]. Principal Component Analysis is a eigenface approach used for face recognition. PCA reduces the large dimensionality of the image space to the smaller intrinsic dimensionality of the image space. PCA converts faces into most important characteristics as eigenfaces, the important elements of the learning set of images. To recognize a face, a new face image is projected within the eigenface subspace and after projection the human face is classified by performing comparison between the position in eigenface space and the position of identifying people. Various steps are to be performed for PCA algorithm. Firstly, the data is to be standardized and convert covariance and correlation matrix into eigenvector. Assemble these eigenvector into descending order and select the vector with largest eigenvalue. Construct the projection matrix from the largest eigenvector and finally, convert the original datasets into a feature subspace. PCA basis vector is defined as eigenvector of the scatter matrix ST,

$$ST = \Sigma N i=1 (xi - \mu) (xi - \mu)T$$

(3)

D. Color Based

In this feature are detected on the basis of their skin color. Any non-skin color space in the face is regarded as a candidate for eyes and nose. This proposed technique uses the face image mean and standard deviation features for feature extraction. This method overcomes the challenges faced by appearance based approach. Different skin color algorithm is RGB color space, YCbCr color space and HSI colors pace [4]. We are going to discuss RGB color space. In this, we convert RGB vector into a normalized vector [r, g] for faster means of skin detection. The detected skin is the localized face. With the help of threshold, we find skin color from an image as:

$$if\ R + G + B\ 3 \geq T\ \ \{P(x, y) = white\ ,\ P(x, y) = blac\}$$

(4)

Where T is the threshold, p(x,y) is the current pixel with coordinating position x,y and RGB represents the Red, Green, Blue associate with pixel value.

V. IMAGE RECOGNITION AND FEATURE EXTRACTION: BACKGROUND AND REVIEW

It has been seen that for high efficiency and accuracy, the input image must be of high quality without having any noise. Performance depends on the quality of an image and the time taken by the algorithm. Now, further, we will study various ways in which a recognition and feature extraction can be made highly accurate which are proposed in a literature. Xuemie Zhao [1] presents a modified local binary pattern histogram algorithm to overcome the condition of expression variation, illumination diversification and attitude deflection is

decreased. The algorithm is based on the pixel neighborhood gray median. In this gray value of pixel is replaced by the median value of its neighboring value, and then extract feature value by the sub blocks and the statistical histogram. Gulzar [3] presented, a low cost safety system for automobiles, security which also involves all types of door locked. The methodology regulates the a higher quality product with reference to documentation standards, code optimization, user acceptance due to adequately efficient, maintainable, consistence and cheaper software. The proposed model is designed to take advantages of utilizing each fisherface method and eigenface method. Author used Arduino in his system to make his proposed algorithm cheaper, user friendly and simple to configure. On this the recent version of the Compute Stick is powered by an Intel Atom Z8300 4GB of RAM, with 32 or 64GB of EMMC storages has been used. This model mainly focuses on the terms of price and use. This approach consists of 4 phases: capturing, training, detection and recognition. To overcome the drawback of unsatisfactory recognition rate the combination of fisherface technique and eigenface technique is used. The problem faced by this algorithm is, the Arduino does not have its own operating system. To overcome this we can use Raspberrypi device.

Wasif Khan [4] discussed to develop a new feature from the integration of different feature extraction techniques to improve the performance of object identification and classification. In this technique k-nearest neighbor classifier is used. The proposal of k-NN algorithm assigns the class label to the question sample established on the majority vote among its k nearest neighbors. To overcome the issue of reliability Microscopic Kinect camera is present. This particular camera is required to capture the high quality of the RGB images. The 2D RGB images lack the knowledge in regards to the shape and feature of the object. RGB-D images has been used to achieve excessive performance and to get a lot information about the object. On this paper, methodology regulates the proposed procedure, including three techniques that are data preprocessing, feature extraction and classification. Author uses the bilateral filter for the pre processes of the data. For this, the effect has been considered on the basis of category level and the instance level. The proposed algorithm indicates that the combination of different features of RGB-D images are more compatible than HMP approach. It takes relatively lesser time and high speed which makes algorithm cost effective. CNN classifier is far time consuming as compared to k-nearest neighbor classifier. The proposed results additionally expose that this technique offers 8% better outcome in Depth category recognition while almost 2% in depth instance recognition when compared to HMP on 70 30 folds of training and testing out, respectively.

aleh Albelwi [5] proposed technique to improve the accuracy of face recognition technique. The author proposes the integration of multiple extraction features with the deep learning approach. In this method, the author integrates the output of three different extraction techniques, i.e. principal component analysis, the combination of local binary patterns and the principal component analysis, and using Neural Network to reduce the dimensionality of LBP features. The output of the above three techniques is used to form a joint feature vector. This feature vector is fed into a deep Sacked Sparse Autoencoder (SSA) as a classifier to generate the recognition results. ORL and AR face database is used to test this technique.

Narayan T. Deshpande [6] presented an algorithm which is the fusion of feed forward neural network and principal component analysis for recognition to achieve better accuracy. To detect a face he uses viola-Jones algorithm. For testing he uses BIO Id-face-database as the standard image database. After studying we see, this technique gives more accurate results than compared with other methods. In this technique, Viola-Jones algorithm is failed to detect the facial features of the tilted image.

R Benedict [7] uses facial feature extraction for face recognition. He proposes geometrical shaped facial feature extraction to recognize a face. By finding the center and corners of the eye using eye detection and eye localization modules, we can find the exact person. In this, face map is also considered. After giving the input image, the face map gets initialized and processed within the type of coarse-to-fine manner with two modules. The initial module, eye detector is used to detect the eye patter making use of Gabor filter. In the 2nd module, the SVM classifier is used to find the center of the eye, so that less time is used for localization. After locating the corners and the center of eye fiducial aspects are determined from which the face of a human gets recognized. High performance and less cost are observed while performing this technique. The challenges face in this is when the input image is slightly tilted.

Namrata Singh [14] proposed algorithm on the basis of to have high frequency and speed. He introduced template matching algorithm using cross correlation method to recognize a face. For this, the author also proposed an approach for face detection

which includes certain characteristics like lightening compensation based on luminance (Y) & chrominance (Cr), Color segmentation, skin tone statistics & eye-mouth region computation to detect the face. To test this technique, the author considered single face containing an image with frontal view to detect and recognizes a face. The limitation of this approach is not used for feature extraction and matching with feature constraints like pose variance and age. He uses DCT algorithm for vector quantization. This paper is evaluated on the basis of speed and accuracy.

VI. CONCLUSION

In designing a face recognition technique, the greater challenge is the high efficiency, performance and accuracy for recognizing a face. To overcome the challenges or the drawback, they're exiting a number of techniques and algorithm. In this we revised different research papers on face recognition and feature extraction for face recognition. It is necessary to choose a better algorithm and a low cost hardware to achieve better performance and high accuracy. In future, advance work is to be performed to have better efficiency. After doing the survey of feature extraction techniques, different methodology has been studied like integration of multiple extraction features in [3] and geometrical shaped facial feature extraction in [8] to recognize a simple human face. In the future, we can integrate these approaches and propose a new facial feature extraction technique for tilted image which will overcome the challenges faced by existing techniques for efficiently extract the facial features from a tilted image and to recognize the tilted image.

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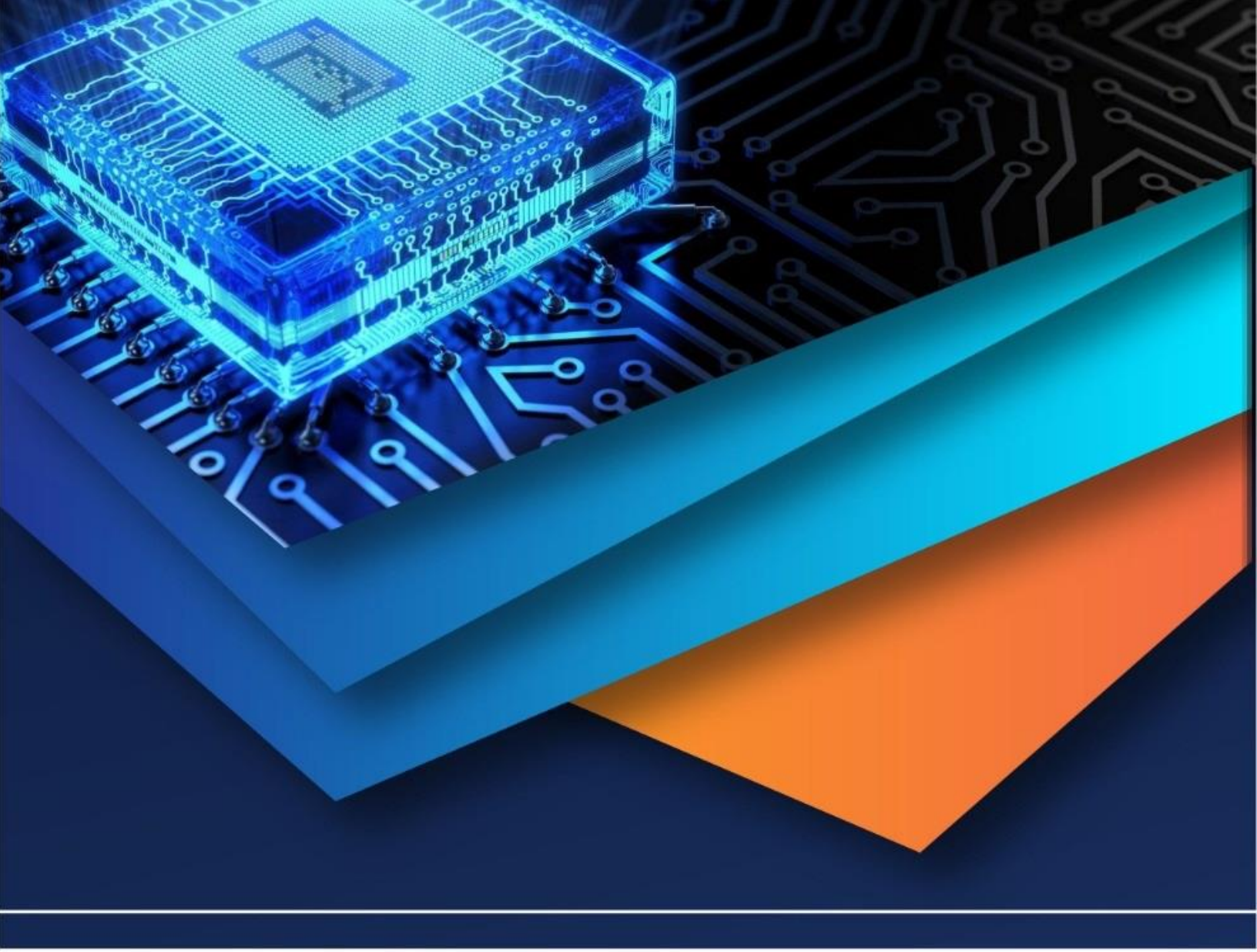

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