
Intelligent Image Recognition frame work: An Exhaustive Survey of face detection & Facial feature Extraction approaches

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Abstract

In this paper an exhaustive investigation of existing image recognition techniques has been taken up. On the basis of various approaches and their performance criteria, it is proposed to use one of the available techniques with slight changes in the performance parameters. Also new hybrid mechanism for improving the performance of the existing feature extraction has been studied and investigated for furthering performance.

Keywords

Image Recognition, Face Detection, Facial Feature Extraction, Image Acquisition, Neural Network, Template Based Approach.

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Introduction

Though the normal people are quite good at image identification and recognition but making it possible using computer is very difficult. The basic concept of image recognition system is to find out the identity of a person through captured image compared with the already stored image in the database. Various multinational companies, corporate offices, high security areas, banks and renowned institutions are using biometrics oriented check in systems. The image recognition system has an extra ordinary advantage on these biometric oriented system is that the active participation of user is not required in image recognition systems. It can be widely used in credit card verification, criminal identification and surveillance systems. Huge database are now available to the world, from collection of photographs to Internet web pages Image recognition is now basic thing in digital Images processing^[1]. Mostly, Image recognition may be organized in few following steps^[2].



Figure 1. Image Recognition framework

Designing of Image recognition frame work needs attention on the following Important Points that are Image pattern classes, Image representation, feature selection and extraction, designing of classifier and Learning, selection of samples for testing and recognition level.

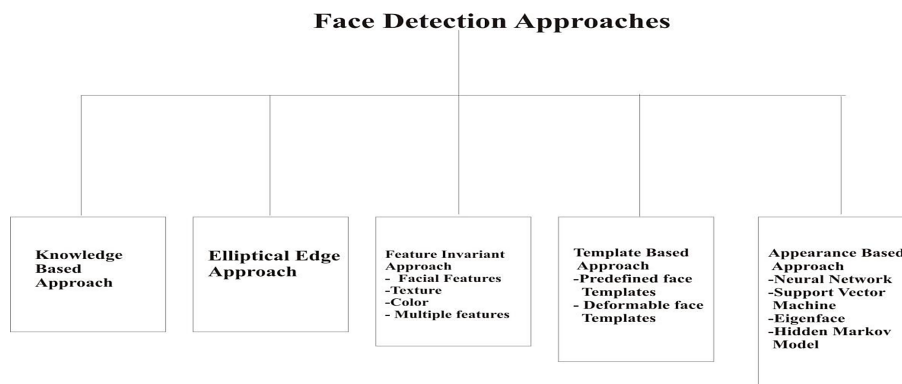


Figure 2. Face Detection Approaches

Since the development work started in the field of Image processing the general problem of recognizing Images with different orientation, size and scale still required to be solved. Due to the introduction of newly developed applications in the field of data mining, web searching, recognition of human Images and face, it is required to generate a robust, efficient and accurate Image recognition framework^[3].

Image acquisition

It is the creation of digital Image, typically from a physical scene. The term assumed to imply compression, storage, printing and display of Images. The first stage of any vision/Image processing system is the image acquisition stage. Once the image has been obtained various methods of preprocessing can be applied to the digital Image to perform many different vision task. however if the Image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of Image Enhancement.

There are several devices through which one can acquire the Image. The first choice of Image acquisition device may be a TV camera where out put is a video signal. But this form of device has limited resolution. A finite no of scan lines (about 625) and frame rate (30 or 60 frames per second). This type of device also give unwanted persistence between one frame and the next and non linear video out put with respect to light Intensity. CCD Camera may be other choice which give less geometric discretion and more Linear Video output. Image acquisition can also be done using image scanner & can acquire the Image directly in the required formats.

Image normalization/Preprocessing

This step performs three basic function i.e. auto cropping, centering and normalization of the digital Image, which consist of the non square to square Image, scaling of Image with keeping the main features of the Image intact and applying a repeated rotational process with required angle^[4].

Image preprocessing is the another Important content of Image recognition frame work so that efficiency of the system can be obtained. Preprocessing consist of converting color Images to grey scale Images^[5]. Digitizing & thresholding^[6] is also on Important part of preprocessing so that afterwards some key Information may be stored in the knowledge base. Grey level transformation may be applied on Individual pixels Intensity values^[7]. This help to keep all the digital Images in the same grey level mapping.

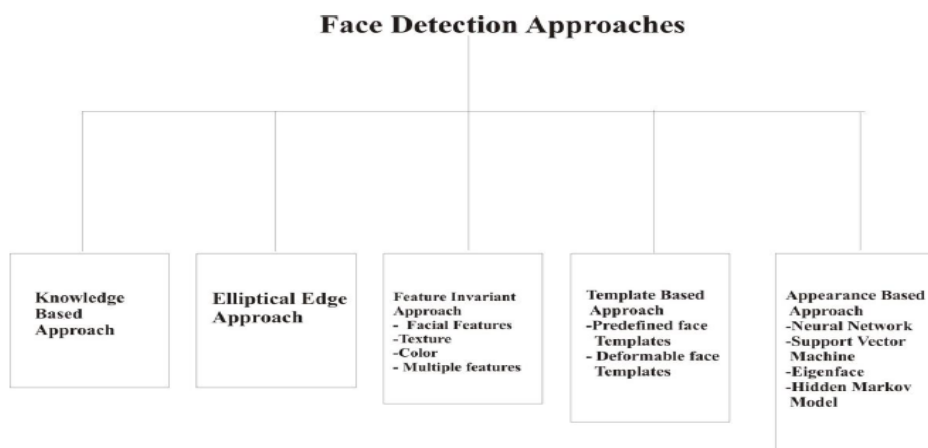
The Image Processing system may suffer from noise like line segments are touched, Isolated pixels and smeared Images. The noise may create distortion in the digital Image which results in low recognition & verification rate. So preprocessing should be used to discard noise^[8]. Normalization is used to standardize the Intensity values of digital Image by manipulating the range of grey level values.

Face detection

Given an Image, detecting the presence of human face is a critical work because of the variations of the face. The different sizes, angles and poses of a human face may cause the variation in digital Image. The emotions which comes from human face and Imaging conditions like illumination and occlusions also affect facial appearances^[9,10]. Along with these parameters wearing glasses, hair style, beard and make up on face have also considerable effect in the facial appearance^[11].

face detection approaches can be generally classified in the four types i.e Knowledge based approach, feature invariant approach, template based approach and appearance based approach^[12].

Knowledge-based approach/rule based approach



This is based on rules drive from the knowledge base of the face geometry. Mostly the rules are defined on the basic of relative distance and positions of facial features like eye pairs, nose, mouth, chin etc. Yang and Huang^[32] used a hierarchical knowledge based method to detect faces. Hierarchical class search method will lead to an increase in execution speed. One difficulty which is faced in this approach is to convert the knowledge of face geometry in to effective rules, hard rules may fail to detect faces and general rules may increase incorrect detection of faces. Detecting faces in all cases through this approach is not possible^[13,14].

Elliptical edge approach

This is based on the assumption that the face is an approximation of ellipse curve shape and assume that there is an obvious edge line between the face and the background. This method is simple and fast but obvious edge in the background may wrongly judge man face. This may more prone to errors if background is complex edge line. When the background is more simple this method is very effective^[15]. The method is simple and fast but it can misjudge the human face if the complex edge line in the background.

Feature Invariant approach

This approach find structural features of digital image. Features are detected and grouped according to the geometry of the face. It is very critical to select the set of appropriate features. Noisy Images and occluded Images which weaken the feature boundaries can not be suitably detect using this approach. This approach is not affected by the geometry transformation like rotation & scaling so this gives a good solution to facial features detection problem^[16]. Human skin color has also been attracted researchers as a significant feature because skin color has a small color range in different color spaces regardless of the race and cast^[17,18]. It has proven to be a robust cue for face detection, localization and tracking. Parametric skin modeling methods are good for constructing classifiers. This method can construct classifiers with average performance from incomplete training data.

Template based approach

In this approach the digital Image, represented as bidirectional array of Intensity values with one template representing full face. A standard pattern of a human face is used as the base in this approach.

The pixels of Image window are compared with standard pattern to find out the human face in that window. This approach is being used in face localization and detection. Sakai et al. made an attempt to detect frontal faces in photographs. They used several subtemplate for the eyes, nose, mouth and face contour to model the face. This approach is simple enough but not capable of dealing with human face variations^[19,20].

Appearance based approach

The appearance based methods are used for face detection with eigenface^[21], neural network^[22] and Information theoretical approach^[23]. Appearance based approach considers the human face as pattern of pixel Intensities. Non face patterns are not used in the training of this approach hence it is not very robust. It's time complexity is more as the no. of patterns which needs to be tested is large. A neural network is good for capturing complex facial patterns from facial Images. Support vector machine (SVM), eigenfaces, distribution based approaches, naive bayes classifiers, Hidden markov models (HMM) and information theoretical approaches can also be used for detection of faces.

In spite of minimizing training error as in neural network, support vector machine operate by minimizing the upper bound on the generalization error. Eigenfaces is a probabilistic visual learning method, naive bayes classifier provides good assessment of the conditional density functions in facial regions. The hidden markov model does not require exact alignment as in template based and appearance based approaches. HMM usually view a face pattern as a sequence of observation vectors. Researchers have also used the hybrid method of face detection in which combination of two approaches are used for robust and efficient face detection^[24].

Facial Feature Extraction

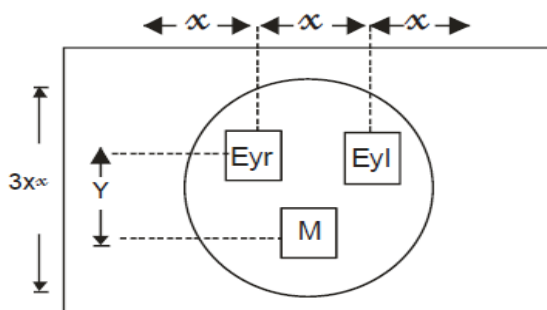
The frame work of face recognition also involve many complications. The different facial expressions, direction of light of Imaging, different pose and postures, size and angle. Same people in different surroundings may look unlike. Facial feature extraction is an important part of Image recognition framework. Detecting the basic facial features like eyes, mouth, nose & chin are required for most Image recognition framework. The feature detection is a challenging problem in Image recognition because of gender, race, expressions and surroundings at the time of Image acquisition like lighting, scaling etc.

The basic approaches of feature extrication are luminance, chrominance, geometry based Technique, color based Technique, appearance based Technique and template based Technique. The hybrid of these approaches are also found^[25].

Luminance, chrominance & geometry based techniques

Extracting the features using facial geometry and symmetry and the visual characteristic of face are important. The face of human is consist of various features. The symmetry of the human face help in detecting facial features irrespective of differences in size & shape of features. The method is effective on frontal face Image containing a mouth and two eyes as shown in fig 1.

Frontal face analysis view (fig1) Eyr and Eyl are right and left eye position respectively & M represent the mouth. The distance between two eyes is x and distance between mouth & eyes is Y . In Images consist of frontal face, structural relationships of features are very useful to constrain the facial feature detection. In geometry based techniques the feature extraction is based upon size and the relative position of landmark component of faces. The feature vectors are constructed by detecting edges and direction of



landmark components of faces. Canny filter are used to detect eyes or mouth region of facial image. One of the important method of this approach is Gabor wavelets transform [26].

In extracting features based on luminance & chrominance the general method is to locate the eyes based on valley points of luminance in eye region. It is conformed by the observations that under normal illumination, facial features contain relatively low grey levels and that the intensity histogram of the face produces a shape of two peaks: The peak in the lower grey levels of histogram is caused by the darker parts of face such as eyes, the other peak is caused by lighter parts such as cheeks and forehead. The use of intensity histogram is being extensively used in extracting features based on luminance & chrominance [27]. Different researcher proposed different method based on different no. of features like 2 eye balls, 4 far and near points of eye, 2 mouth points and midpoint of nostrils etc.

Template based approach

In view of improved outcome, some researchers direct their research approach on unique shape of features. Each feature has defined with separate template [28]. Deformable template to extract eyes, nose and face outline were also used.

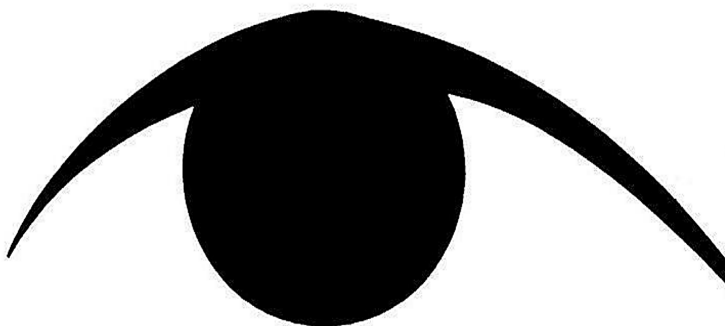


Figure 3. Deformable template of eye

Researchers have also proposed a highly accurate and flexible approach for the extraction of eyes using basic shapes, eye corner detection and deformable templates. The iris is chosen as the first component to extract because of its circular shape and high Intensity contrast with neighboring regions. Template functions and appropriate energy functions are defined to links edges, peaks and valleys in the image Intensity with corresponding properties of template. Then by matching of template with the Image and varying its parameter values to minimize the energy function and deform itself to find the best fit. The final parameter values can be used as descriptors for features.

Color based feature extraction

In this approach skin region is detected by use of Ycbcr, RGB and HSV color models with certain Image of color pixels. After getting skin region facial features i.e. eyes and mouth are extracted. The Image is then binarized and transformed to grey scale Image and than to binary Image after thresholding. This process is performed to discard the hue and saturation values and taken only luminance. This luminance part is converted to binary Image with some threshold value because face features are dark then the background colors. The morphological operations to remove the noise is done. Then the facial features can be extract form binary Image^[29].

Appearance based techniques

Appearance based approaches aim to design the facial feature in a suitable subspace as principal components analysis (PCA)^[30]. Independent component analysis (ICA), discrete cosine transform (DCT), gaussian derivative filters etc. Once the Image is converted in to subspace representation, various Machine learning Techniques like boosted cascade detectors^[31], Support vector Machine and multilayer perception (MLP) are applied. This type of methods uses linear transformation and statistical methods to find the basic vectors to represent the face. PCA method reduce the no of dimension of feature space but preserve the principal features to reduce the loss of Information. The disadvantage of PCA is that high order dependencies still exist in PCA analysis. ICA technique not only use second order statistics but also use high order statistics. In non-gaussian source models ICA performs better than PCA. This appearance based approach performs good in facial feature extraction because important Information of face Image is Intact and it rejects the redundant information. The disadvantage of this approach is high computational cost.

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