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Review of Effective Face Detection & Recognition Techniques

Poonam V. Kadam

Assistant Professor, Department of Computer Engineering, Metropolitan Institute of Technology & Management (MITM), Sindhudurg, Maharashtra, India

ABSTRACT: A lot of research work is going in this direction to increase the visual power of computer. Hence, there is a lot of scope in the development of visual and vision system. But there are difficulties in the path such as development of efficient visual feature extracting algorithms and high processing power for retrieval from a huge image database. As image is a complex high dimension (3D) matrix and processing matrix operation is not so fast and perfect. Hence, this direction us to handle with a huge image database and focus on the new algorithms which are more real-time and more efficient with maximum percentage of accuracy. Efficient and effective recognition of human face from image databases is now a requirement. Face recognition is a biometric method for identifying individuals by their features of face. Applications of face recognition are widely spreading in areas such as criminal identification, security system, image and film processing.

Face detection and recognition technology has been widely discussed in relation to computer vision and pattern recognition. Numerous different techniques have been developed owing to the growing number of real world applications. For service robot, face detection and recognition are extremely important, in which the emphasis must be put on security, real-time, high ratio of detection and recognition. My paper is review of some face detection and recognition techniques.

KEYWORDS: Face detection, Face recognition, Feature Extraction, Face Databases

I. INTRODUCTION

Over the last few years or so, face recognition has become a popular area of research in computer vision. Face recognition is also one of the most successful applications of image analysis and understanding. Because of the nature of the problem of face recognition, not only computer science researchers are interested in it, but neuroscientists and psychologists are also interested for the same. It is the general opinion that advances in computer vision research will provide useful insights to neuroscientists and psychologists into how human brain works, and vice versa.

The topic of real time face recognition for video and complex real-world environments has garnered tremendous attention for student to attend class daily means online attendance system as well as security system based on face recognition. Automated face recognition system is a big challenging problem and has gained much attention from last few decades. There are many approaches in this field. Many proposed algorithms are there to identify and recognize human being face form given dataset. The recent development in this field has facilitated us with fast processing capacity and high accuracy. The efforts are also going in the direction to include learning techniques in this complex computer vision technology. There are many existing systems to identify faces and recognized them. But the systems are not so efficient to have automated face detection, identification and recognition.

II. FACE DETECTION

Face detection is a technology to determine the locations and size of a human being face in a digital image. It only detects facial expression and rest all in the image is treated as background and is subtracted from the image. It is a special case of object-class detection or in more general case as face localizer. Face-detection algorithms focused on the detection of frontal human faces, and also solve the multi-view face detection problem. The various techniques used to detect the face in the image are as below:

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Face detection as a pattern-classification task

In this face detection is a binary-pattern classification task. That is, the content of a given part of an image is transformed into features, after which a classifier trained on example faces decides whether that particular region of the image is a face, or not.

Face detection in Controlled background

In this technique the background is still or is fixed. Remove the background and only the faces will be left, assuming the image only contains a frontal face.

Face detection by skin colour

This technique is vulnerable. In this skin colour is used to segment the colour image to find the face in the image. But this has some drawback; the still background of the same colour will also
be segmented.

Face detection by motion

The face in the image is usually in motion. Calculating the moving area will get the face segment. But this too have many disadvantages as there may be backgrounds which are in motion.

Model-based Face detection

A face model can contain the appearance, shape, and motion of faces [3]. This technique uses the face model to find the face in the image. Some of the models can be rectangle, round, square, heart, and triangle. It gives high level of accuracy if used with some other techniques.

Why Face Detection Is Required?

Face detection is a necessary first-step in face recognition systems, with the purpose of localizing and extracting the face region from the background. It also has several applications in areas such as content-based image retrieval, video coding, video conferencing, crowd surveillance, and intelligent human–computer interfaces. However, it was not until recently that the face detection problem received considerable attention among researchers. The human face is a dynamic object and has a high degree of variability in its appearance, which makes face detection a difficult problem in computer vision. A wide variety of techniques have been proposed, ranging from simple edge-based algorithms to composite high-level approaches utilizing advanced pattern recognition methods.

Face Detection Vs. Face Recognition

Although the terms face detection and face recognition are often used together, facial recognition is only one application for face detection -- albeit one of the most significant ones. Facial recognition is used for unlocking phones and mobile apps as well as for Biometric verification. The banking, retail and transportation-security industries employ facial recognition to reduce crime and prevent violence.
In short, the term face recognition extends beyond detecting the presence of a human face to determine whose face it is. The process uses a computer application that captures a digital image of an individual's face -- sometimes taken from a video frame -- and compares it to images in a database of stored records.

III. FACE RECOGNITION

Face recognition is a formal method which is first proposed by Francis Galton in 1888. Face recognition is a technique to identify a person face from a still image or moving pictures with a given image database of face images. Face recognition is biometric information of a person. However, face is subject to lots of changes and is more sensitive to environmental changes. Thus, the recognition rate of the face is low than the other biometric information of a person

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such as fingerprint, voice, iris, ear, palm geometry, retina, etc. There are many methods for face recognition and to increase the recognition rate.

Face recognition algorithms can be classified into one of four categories, with some algorithms belonging to more than one category. Here are four popular Face Detection methods below:

1. **Knowledge-Based**

For the knowledge-based technique to recognize faces, a set of rules must be followed, and it is dependent on human understanding to do so. For example, a face must have a nose, eyes, and mouth that are all at certain distances and positions from one another.
When it comes to these strategies, the most significant drawback is the difficulty in developing a suitable set of criteria. If the criteria were either too vague or too specific, there might have been a large number of false positives. This method alone is inadequate and is incapable of identifying several faces in a large number of photos.

2. **Feature-Based**

The feature-based technique is used to find faces by extracting structural characteristics from the faces being searched for. It is trained as a classifier first, and then it is used to distinguish between facial and non-facial parts of the body.
Ultimately, the goal is to surpass the limitations of our instinctual awareness of faces. According to the authors, this strategy, which is separated into numerous sections and includes photographs with several faces, has a success rate of up to 95 percent.

3. **Matching of Templates**

It is possible to discover or detect faces using the Template Matching approach, which makes use of pre-defined or parameterized face templates to locate or detect faces by comparing them to the input photos. For example, the human face may be split into four parts: the eyes, the facial contour, the nose, and the lips. Additionally, by using the edge detection approach, a face model may be constructed entirely from edges.
Although this method is straightforward to develop, it is insufficient for face detection. Deformable templates, on the other hand, have been presented as a solution to these issues.
Template matching is a technique used to find matches between two templates.

4. **Appearance-Based**

The appearance-based technique, in order to discover face models, is dependent on a collection of delegate training face photos. The appearance-based approach outperforms all other methods of performance evaluation. When searching for relevant qualities in face photos, appearance-based methods depend on techniques from statistical analysis and machine learning to uncover important characteristics of face photos. This approach is also used in the extraction of facial features for the purpose of face recognition.

Following that, the appearance-based model is further subdivided into sub-methods for the purpose of face detection, which are as follows:

- **Eigenface-Based**
  Face Recognition is accomplished by the use of the Eigenface algorithm, which is a way of effectively modeling faces through the use of Principal Component Analysis.
- **Distribution-Based**
  Facial patterns may be defined using techniques such as PCA and Fisher's Discriminant, which are both based on probability distributions. There is a trained classifier that properly distinguishes instances of the target pattern class from instances of the background image pattern class in the input picture.
- **Neural-Networks**
  Neural Networks have been used effectively to solve a wide range of detection issues, including object detection, face detection, emotion detection, and face identification, among others.
- **Support Vector Machine (SVM)**
  As a linear classifier, Support Vector Machines (SVMs) maximize the difference in likelihood between the decision hyperplane and each of the instances in the training set. Osuna and colleagues were the first to use this classifier to face detection.

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- **Sparse Network of Winnows**
  It was decided to create a sparse network consisting of two linear units or target nodes; one represents face patterns, while the other represents non-face patterns. It is less time-consuming and more efficient than the alternative.
- **Naive Bayes Classifiers**
  They calculated the chance of a face being present in a photograph by counting the number of times a sequence of the pattern appeared in a series of training photos. The classifier was able to collect the combined statistics of the faces' local look and their location on the screen.
- **Hidden Markov Model**
  The facial characteristics of the model would be represented by the states of the model, which are often depicted as strips of pixels. HMMs are often used in conjunction with other approaches to construct detection systems.
- **Application of Information Theoretical Principles**
  Markov Random Fields (MRF) is a kind of random field that may be used to analyze facial patterns and connected characteristics. The Kullback-Leibler divergence of the Markov process is used to maximize the discrimination between classes in the data. As a result, this technology may be used for the detection of faces.
- **Inductive Learning**
  Face detection has been accomplished via the use of this method. This is accomplished via the use of algorithms such as Quinlan's C4.5 or Mitchell's FIND-S.

IV. FEATURE EXTRACTION TECHNIQUES

Facial feature extraction is necessary for identification of an individual face on a computer. As facial features, the shape of facial parts is automatically extracted from a frontal face image. There can be three methods for the facial feature extraction as given below:

Geometry-based

This technique is prosed by Kanada the eyes, the mouth and the nose base are localized using the vertical edge map. These techniques require threshold, which, given the prevailing sensitivity, may adversely affect the achieved performance.

Template-based

This technique, matches the facial components to previously designed templates using appropriate energy functional. Genetic algorithms have been proposed for more efficient searching times in template matching.

Colour segmentation techniques

This technique makes use of skin colour to isolate the facial and non-facial part in the image. Any non-skin color region within the face is viewed as a candidate for eyes and or mouth. Research and experiments on face recognition still continuing since many decades but still there is no single algorithm perfect in real time face recognition with all the limitations discussed in second section. Here a new approach is proposed to somewhat overcome the limitations with a very less complexity.

V. STANDARD DATABASE FOR FACE DETECTION

Face image databases are collection of different type of faces, which may be used as test set for face detection system. Some standard face image databases are available, which are following

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Sr. No.	Database	Description
1	MIT dataset	19×19 Gray-scale PGM format images Training set: 2429 faces, 4548 non-faces Test set: 472 faces, 23,573 non-faces
2	PIE database, CMU	A database of 41,368 images of 68 people, each person under 13 different poses, 43 different illumination conditions, and with 4 different expressions
3	FERET database	It consists of 14,051 eight-bit gray-scale images of human heads with views ranging from frontal to left and right profiles
4	The Yale face database	Contains 165 gray-scale images in GIF format of 15 individuals. There are 11 images per subject, one per different facial expression or configuration: center-light, w/glasses, happy, left-light, w/no glasses, normal, right-light, sad, sleepy, surprised, and wink
5	SCface—surveillance cameras face database	Images were taken in uncontrolled indoor environment using five video surveillance cameras of various qualities. Database contains 4160 static images (in visible and infrared spectrum) of 130 subjects
6	Indian face database	11 images of each of 39 men, 22 women from Indian Institute of Technology Kanpur
7	AR database	It contains over 4000 color images corresponding to 126 people's faces (70 men and 56 women). Features based on frontal view faces with different facial expressions, illumination conditions, and occlusions (sun glasses and scarf)

VI. CONCLUSION

The proposed paper briefly discuss about a critical survey of existing literatureon humanand machine recognition of faces. It provides the general guidance of theface detection approaches. It also describes some Face recognition systems. The main advantage of the holisticapproaches isthat they do not obliterate any of the information in the images by focussing on onlylimited regions. However, as mentioned above, this sameproperty or feature extraction is almost the drawback, since most of these approaches follows the basic assumptionthat all the pixels in the image are equally important. It is very important to choose right technique for face detection and recognition by considering which technic is suitable for what kind of application.

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