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FACIAL COMPOSITE SYSTEM USING REAL FACIAL FEATURES

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Abstract

Facial feature points identification plays an important role in many facial image applications, like face detection, face recognition, facial expression classification, etc. This paper describes the early stages of the research in the field of evolving a facial composite, primarily the main steps of face detection and facial features extraction. Technological issues are identified and possible strategies to solve some of the problems are proposed.

Key words

Face recognition, face detection, facial feature points, facial features extraction, facial composite system

Introduction

There are three different approaches to obtain an identikit of a suspected person, which are used during the crime investigation by forensic artists. The first one is based on the witness testimony where a forensic artist draws a face as described by the witness. The other one uses a computer based programs such as E-FIT (1), PRO-Fit (2), Faces (3) etc. These programmes need individual facial components selection (eyes, mouth, nose, etc.) for creating a composite. The two approaches mentioned above are difficult to implement, time and psychologically challenging, whereas the witness has to recall the face and describe all its features with highest precision. However, people rather remember the face as a whole entity than its individual features, and therefore the current research is focused mainly on the third approach, which uses computer programs such as Evo-FIT (4) and Eigen-FIT (5) to generate the whole faces. For the generated faces, it is important to achieve resemblance with a real human being, rather than provide a computer-made sketch. Therefore, the main focus of this article is to obtain facial elements (features) from a photograph of a real human face.

Facial composite system description

The first step in automated face features extraction is the face detection. Reliability of the face detection represents the main factor of the applicability and performance of automatic face recognition as well as for feature extraction and further automated composition of a face. Since the ideal detector should be able to find all present faces in the pictures or video, it should be capable of identifying them regardless of their location, scale or orientation (6).For the purposes of our research, we consider the ideal profile of photographs. Our face composition system consists of four parts as depicted in Figure 1: face localization, normalization, feature extraction and application of genetic algorithm proposed in (7) on building a face. The parts are explained below.

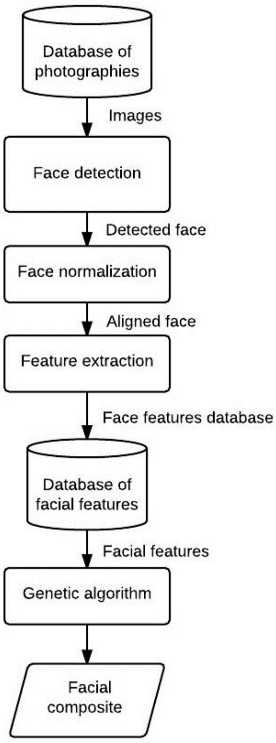

Figure 1 *Face composition system - processing flow*

In the first stage of *Face detection*, the face area is separated from the background. In the case of video, the detected faces may need to be tracked across multiple frames using a face tracking component. While face detection provides a coarse estimate of location and scale of the face, face landmarking is necessary for localizing the facial landmarks (e.g., eyes, nose, mouth and facial outline). This may be accomplished by a landmarking module or a face alignment module.

Face normalization is performed to normalize the face geometrically and photometrically. This is necessary for standardizing the pose and illumination. The geometrical normalization process transforms the face into a standard frame by face cropping. Warping or morphing may be used for more elaborate geometric normalization. The photometric normalization process normalizes the face based on the properties such as illumination and grey scale.

Face feature extraction is performed on the normalized face to extract the salient information that is useful for distinguishing the faces of different persons; it is robust with respect to the geometric and photometric variations (6).

Detection of facial features

Hair, face out-line, eyes and mouth have been determined to be important for perceiving and remembering faces. It was found that the upper part of the face is more useful for face recognition than the lower part. The eyes are an important feature that can be consistently identified (8).

Three types of feature extraction methods can be distinguished:

- generic methods based on edges, lines, and curves,
- feature-template-based methods,
- structural matching methods.

Eyes detection

The eye region is composed of dark upper eyelid with eyelashes, lower eyelid, pupil, bright sclera and the skin region that surrounds the eye. The most continuous and non-deformable part of the eye region is the upper eyelid, because both pupil and sclera change their shape with various possible situations of eyes; especially when the eye is closed or partially closed. So, the inner and outer corners are determined by analysing the shape of the upper eyelid (17).

The inner eye corner of the right eye is the point of the contour situated on the very right and the outer eye corner is the leftmost point of the right eye contour. For the left eye, the point situated on the very right becomes the inner corner and the leftmost point is the outer corner. The whole eye contour region is then divided vertically into three equal parts, and searching for the upper and lower mid eyelid is then done within the middle portion (17).

Nose detection

Nostrils of a nose region are the two circular or parabolic objects having the darkest intensity. For detecting the centre points of nostrils, filtering operation on the isolated nose region image is performed using the Laplacian of Gaussian as a filter. The filtered binary image complements the image intensity, and thus changes nostrils as the brightest part of the image. Searching for the peak of local maxima is then performed on the filtered image to obtain the centre points of the nostrils (17).

Mouth detection

The simplest case of the mouth feature points detection occurs when mouth is normally closed. However, complications arise in the process when mouth is open or teeth are visible between lips. These two situations provide additional dark and bright regions in the mouth contour and make the process of feature point detection quite difficult. If there are no complications, all the contours are then identified by applying the 4-connected contour following the algorithm specified in (18), and the mouth contour is isolated as the contour having the largest area.

The right mouth corner is then identified as a point over the mouth contour having the minimum x-coordinate value. The point which has the maximum x-coordinate value is considered as the left mouth corner. Middle points of the right and left mouth corners are calculated, and the upper and lower mid points of the mouth are obtained. These points are gained by finding two specific points over the mouth contour of the same x-coordinate, but they have the minimum and maximum y-coordinates (17).

Facial features extraction using manual landmarking

According to (8) many facial recognition systems need facial features in addition to the holistic face, as suggested by studies in psychology. It is known, that even holistic matching methods, for example, eigenfaces (9) and Fisherfaces (10), need accurate locations of the key facial features such as eyes, nose, and mouth to normalize the detected face. Facial features can be of different types: region (11, 12), key point (landmark) (13, 14) and contour (15, 16).

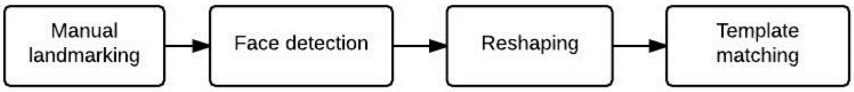

Figure 2 *Facial feature extraction using manual landmarking*

Generally, the key point features provide a more accurate and consistent representation for alignment purposes than the region-based features, with lower complexity and computational burden than the contour feature extraction. An example of the facial feature extraction using manual landmarking is depicted in Figure 3.

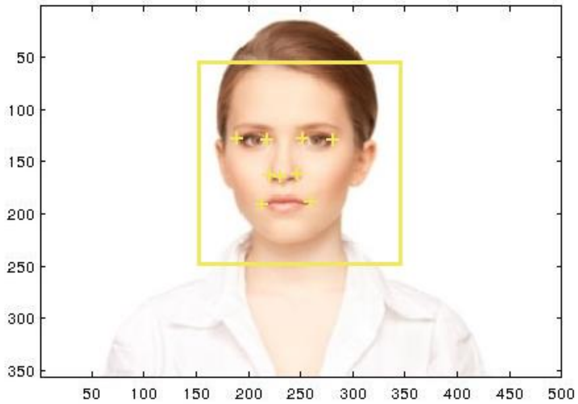

Figure 3 *Facial feature extraction using automated face detection*

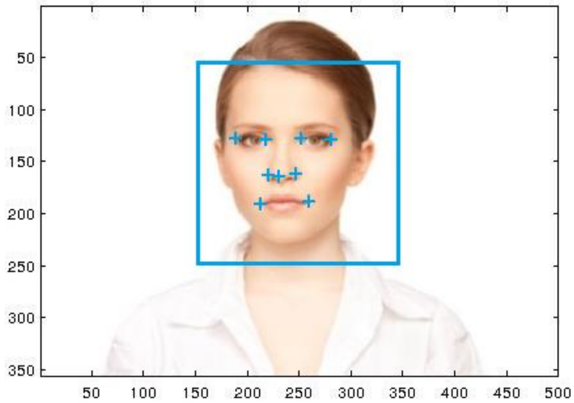

Figure 4 *Facial feature extraction using manual landmarking*

Automated feature extraction

In order to simplify the process and to shorten the processing time, automated face detection (key feature points landmarking) was proposed by (19). We applied and evaluated this approach when using it for the facial feature extraction.

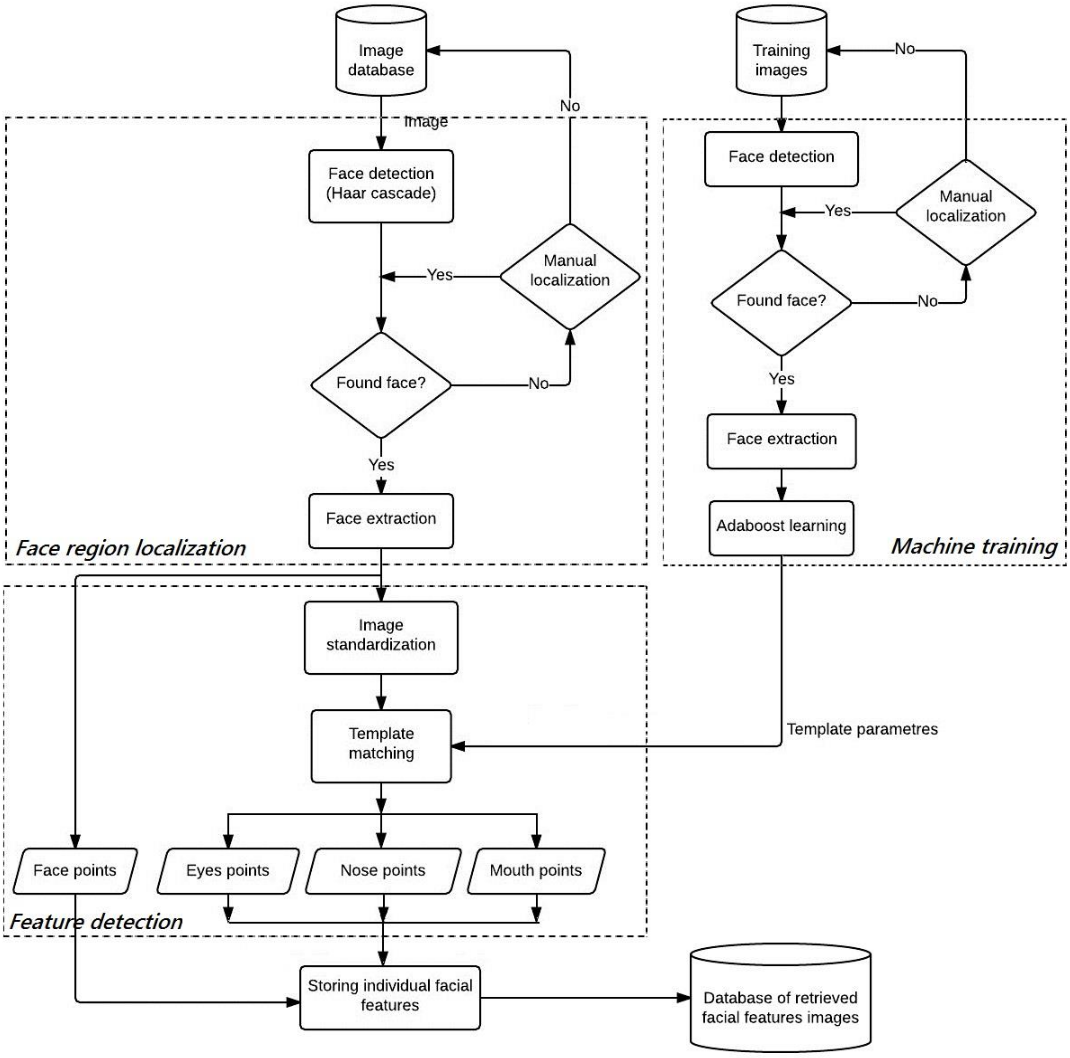

Figure 5 *Automated feature extraction*

Facial features represented by nine feature points across the face (Figure 4) were detected and extracted from the normalised facial images using the OpenCv (20) algorithm (Figure 6).

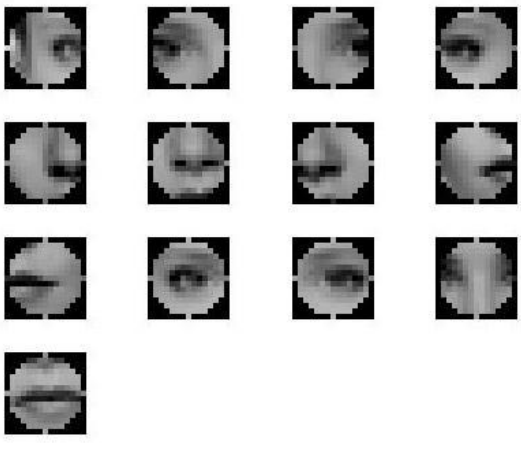

Figure 6 *Extracted facial features*

This approach is based on applying the Viola-Jones (19) algorithm and Haar-like features (21) theory. The quality of results is comparable with the manual landmarking approach (Figures 3, 4).

Conclusion

The paper deals with facial feature extraction methods. The quality of results obtained when applying the automated approach was evaluated as acceptable for the next processing. The future work is to be focused on preparing a database of facial features and its consequent utilisation in the facial composite system proposed in our previous research (7).

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