Manipulating Facial Appearance Through Age Parameters

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Abstract. Nowadays a wide variety of warping applications is known, like educational ones and entertainment ones. The method presented in this work modifies conventional warping techniques in order to applicate it in ageing facial manipulation. We used ageing curves of facial region to show forward and backward ageing face.

Key Words: ageing parameters, warping application, frontal facial ageing

1 Introduction

The computer graphic techniques applied to promote a metamorphosis process over images and objects are classified as *Morphing* and *Warping*. These techniques have been applied in different areas. Some applications are in the generation of special effects in the entertainment industry and other artistic areas. However image processing applications of warping are increasingly important. These applications include corrections in satellite imaging distortions or ultrasonic medical imaging. Other class of applications is facial animation. They include videophones, automated face recognition or psychological studies.

This article focuses a new range of facial animation application: the facial age characterization.

2 Ageing Parameters

In the present paper we used the ageing parameters defined in [Pitanguy et al.(1996)]. Those parameters were obtained after measuring some facial regions in patients that have been photographically recorded along their lives. The purpose of this was to find a pattern for change of those parameters. Curves were defined to describe the pattern of change of the ageing parameter. This was possible after selecting a population of 40 women, whose photographs were scanned in different ages using a 600 dpi scanner. The grayscale images were treated using the Photostyler software. The coordinates of 26 measurements in each face were determined. It was found a strong correlation between age and behavior of the parameters. The evolution of the parameters was non-linear and could be best represented by second-order polynomial equations, although some parameters showed an inflection point at a certain age. It was found a strong correlation between age and behavior of the parameters. This work was based on ageing curves of facial regions. So it was possible to manipulate those parameters in face images. The metamorphosis process, described in this paper, uses a set of curves to interpolate control segments drew in face images. The measured points take part of these set of control lines. The aim of this research is to realistically and scientifically represent the frontal facial ageing.

3 The Used Image Interpolation Technique

Digital image warping has received a lot of interest in recent years. Researches have developed a number of

algorithms for implement this technique [Sorensen (1992)].

The frequently used warping algorithms transform an image based upon contour interpolation. Working with two different images, a contour selection process is applied to each image. This process defines the image area where the graphical transformations will be set on. The in-between images are generated by a color pixel variation plus a bi-dimensional mapping applied over the two previous images. The color of each pixel in two different images is combined.

The distortion method can be sub-divided in *front* and *reverse mapping*. Using *front mapping*, each pixel of the source image is copied to its final position in the target image. In the *reverse mapping* each pixel of the target image is equalized to the correspondent pixels in the source image. In both techniques the issue is to define how pixels in the source image will be linked to the pixels in the known or unknown final image.

To promote an image distortion we must define a source and a target line over the images. These lines describe the mapping process in between pixels. In the warping method the source line is interpolated to a new position generating an unknown image [Beier and Neely (1992)].

The warping process commonly uses a linear interpolation to specify the new position of the control lines that define the pixels' positions. This pixel evaluation requires a large computational time. This characteristic makes this process very extensive specially over complex images where a large number of segments are required. In this work we used polynomial interpolations based on facial ageing parameters.

The controller segments specify characteristics regions of the face according to the ageing parameters [Leta (1994)].

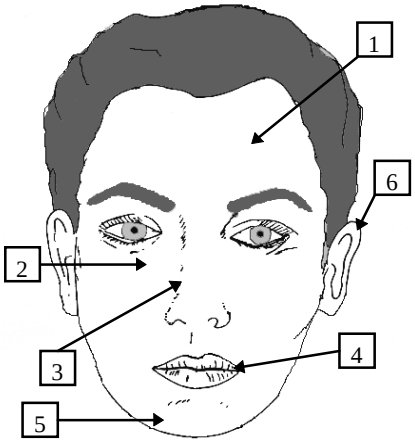

Figure 1. - Face regions according to ageing parameters

The face in figure 1 is devided in regions, considering the ageing parameters previous discussed. Those facial regions are based on [Pitanguy et al. (1977)]. The *frontal region* (1) is limited by the eye-lids and the forehead control lines. The distance between these limits enlarges with forward ageing. *The orbitary region* (2) is one of the most important ageing parameters because a great number of wrinkles appears and the palpebral pouch increases. In *nasal region* (3) is observed an enlargement of its contour. The *orolabial region* (4) is defined by 2 horizontal control segments bounding the upper and lower lips and other 2 segments that define the nasogenian fold. The lips become thinner and the nasogenian fold deeper and larger. The *mental region* (5) have 8 control segments, that define the low limit of the face and descend with ageing.

In figure 2 we present those control segments in the studied face.

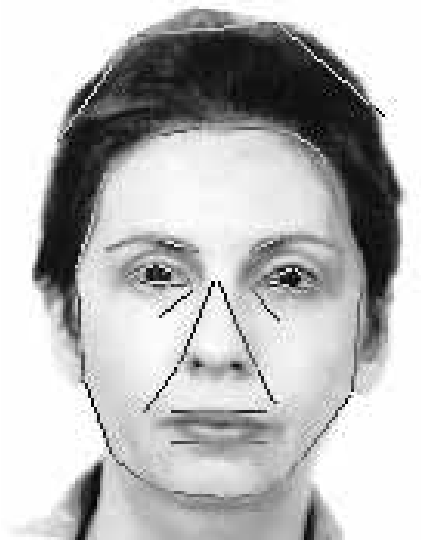

Figure 2. - Representation of used reference warping segments

4 Results

Figures 3 to 5 show examples of facial age manipulation using our implementation in C of the above described thecniques. The images were scanned in 256 gray level and stored in TIFF format. The interpupilar direction was used as horizontal references, if necessary each image is rotated in a pre-processing manipulation in order to match this direction. The feature delineation lines used can be

seen in figure 2. The choice of feature lines was based in the characteristic age points in figure 1. We allocate 39 points as control for a face. Points 0 to 15, as shown in figure 2, refer to the outer contour of the face. Some points define the face border of the image. Extra points were defined to provide additional anchor for the imaging during warping process. An additional of 3 points are placed to form a bounder side of the hairline. The implemented program presents automatically to the operator a standard delineation mask procedure in order maintain high efficient software input. These mask points are manually fit to each image, to be maniputaded, using a mouse. Hair is not the subject of current manipulation, although the front hair region is affected by the transformations.

Faces forming figure 3 consisted of three frames (ages 41 to 51 and 61). Their resolution is 190 x 220 pixels. Figure 4 illustrated the shape transformation from age 41 to 31 and 21, by applying the inverse age transformation. Figure 5 shows the images of figure 3 and 4 combining the two images into one, the original and the transformed by the software, for more effective comparison.

5 Discussion

The research for a quantitative information about ageing parameters is very instigate. Generally biological data are quite difficult to be mathematically represented [Pitanguy et al. (1996)]. The works usually present only qualitative changes in faces, based on parents characteristics. [Burt et al.(1995)] used composite images of different faces trough computer graphic manipulation of shape and color information. Their objective was to obtain an empirical definition of facial changes. [Rowland and Perret (1995)] also presented the color and shape differences between young and old male prototypes to simulate ageing.

In the present work we manipulate facial images using ageing curves. Several points must be commented. First, the perceived change in age between the original and the transformed face independ of if it is backward or forward ageing (as can be seem in fig. 3 and 4) . Second, although we have the nasogenian fold and the length's ear curves, they are not used in the examples bellow. Third, our transformation process is designed to maintain identity and selectively modify ageing attributes. Other *morphing* techniques do not preserve identity, they simply changes one object into another [Hall, (1993)]. Fourth, age transformation can start with a single image of a person and predict future or previous appearance, except for child image.

The natural continuity of this work is introduce some textural cues to age such as wrinkle and color to improve the results. Besides the improvement of color and texture changes, it is also interesting to generate male ageing curves. We suppose that the female and male ageing are different, and so it will be fascinating to compare those curves. Another research that we are developing consists in obtain the ageing curves to facial images in side view and also represent behavior of these curves using warping techniques.

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Figure 3.- Forward ageing, from 41 to 51 and 61years

Figure 4.- Backward ageing , from 21 to 31 and 41 years

Figure 5.- The half-right real image (41 years) and half-left manipulated image (31, 51 and 61 years old)