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Morphing Technique for Creating Composites of Face Images

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Abstract

Face morphing is a technique that makes a transition from one face image to another face image. It has been extensively used in multiple fields of work, such as animation, movie production, games, and mobile applications. There are two types of methods used to conduct face morphing. First is semiautomatic mapping methods, in which users map corresponding pixels between two face images, and produce a transition of result images. Mapping the corresponding pixel between two facial images is usually not trivial. And second morphing method is fully automatic method. It is used for morphing between two images having similar face properties, where the results depend on the similarity of the input face images. This paper describes a method for creating composites with only parts of the face being morphed of facial images. Applications of this technique show how to change only local aspects of a facial image. The experimental results show that position of each face component plays a more important role than the edge and color of the face.

Keywords: Segmentation, Pixels, Face Morphing, Images Morphing, warping.

Introductions

Much morphological work has focused on the perception and processing of human faces [1, 2]. For many experiments, researchers have generated artificial 2D and 3D faces using a variety of techniques [3]. In this paper, I explain how morphing techniques can be used to generate and manipulate faces. For psychological studies, there are two main uses of the morphing technique. First, one can generate facial images that are composites of other facial images. Another application of morphing is the generation of caricatures of a face.

Morphing

The morphing technique can be defined as follows: Given two face images, transform one image into the other as smoothly (visually pleasing) and as fast as possible. The morphing technique involves correspondence problem and color interpolation problem [4, 5]. The procedures described here, which collectively produce the morph, are control point extraction, face image matching, warping and transition control. Fig 1 shows the block diagram of proposed work of morphing technique.

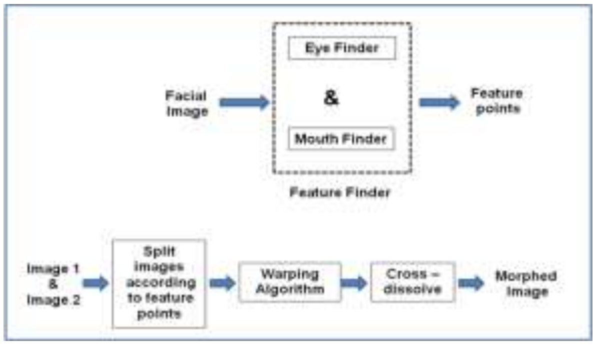

Fig1. Block Diagram of Morphing Technique

A. Control Points Extraction

The choice and number of control points determines the accuracy of two images which can be warped. The use of more number of control points will usually result in a very good warp. However more control points will minimizes the speed of the system since the number of triangles increase, which in turn increases the computation time.

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Image1 Image2

Fig. 2. Location of the control points.

Figure 2 shows control points and feature points for input images. The choice of these facial points as control points is based on the fact that some of their properties, for example, the distances between them, have strong features that can also be used in face recognition.

B. Face-Image Matching

Matching means the establishment of correspondence between various data sets. The matching problem is also called as the correspondence problem. Although the correspondence problem for face morphing is defined specifically as the matching of a subset of predefined points, in this work the face correspondence problem is cast into the more general case where the aim is to match all of the data sets. This can reduce the possibility of having false matches for a few facial features. In addition, using number of points for morphing will improve the quality of the morphing. Face-image matching contains facial feature finding block and splitting images according to feature points block as shown in block diagram.

C. Genetic Algorithms

Accurate extraction of features such as the lips and the eyes is vital for face recognition. We are using a genetic algorithm (GA) to strengthen the results of the segmentation of these regions. It is also used to assist the matching of the general shapes and the segmented areas. In genetic algorithm the fitness function is defined such that the search converges as fast as possible. The fitness function is given as

$$Fitness = \frac{(x-x_i)^2 + (y-y_i)^2 + \sum (z-z_i)^2}{(x+y+z)^2}$$

Where: x, (xi), y, (yi) and z, (zi) are the height, width and the points selected from the shape (segmented area) respectively.

D. Warping

Warping is used when the input images are of the same size, but the faces in them can be of different sizes. The warping method used in this work is triangulation based interpolation. The images are divided into several triangles using the control points already found. The warping transformation from one to the other can be performed using two corresponding triangles, one from the image1 and the other from the image2. Let points P1, P2, P3 on the image1 be located at

$\mathbf{X1} = (u_1, v_1)$, $\mathbf{x_2} = (u_2, v_2)$ and $\mathbf{x_3} = (u_3, v_3)$.

Also let points Q_1, Q_2, Q_3 on the image2 be located at $\mathbf{y_1}=(x_1, y_1)$, $\mathbf{y_2}=(x_2, y_2)$ and $\mathbf{y_3}=(x_3, y_3)$. The points on the image1 can be mapped to those on the image2 using eqs.1 and 2.

$$x = a_{11}u + a_{21}v + a_{31} \tag{1}$$

$$y = a_{12}u + a_{22}v + a_{32} \tag{2}$$

The coefficients a_{11}, a_{12}, a_{21}, a_{22}, a_{31} and a_{32} can be found by solving the equation below.

$$\begin{bmatrix} a_{11} & a_{12} & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} = \begin{bmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{bmatrix} \begin{bmatrix} u_1 & v_1 & 1 \\ u_2 & v_2 & 1 \\ u_3 & v_3 & 1 \end{bmatrix}^{-1} \tag{3}$$

Warping can then be done using image1 to image2 mapping.

E. Color Transition

A morph contains a sequence of intermediate images from the input images to the destination image. Color transition is defined as the method that determines the rate of color blending across the sequence. This rate determines the quality of the morphing image. The color blending rate is usually based on weights. Weights are selected such that the transition between the images on the sequence can be completed smoothly.

The weight for each morph in the sequence is the calculated based on the color difference, the value of the Gaussian function at that point and the number of warps in the sequence. The color for each image in the morph sequence is then calculate using;

$$\varphi_j = \varphi_i - \omega_i * \Delta\varphi_{ij} \tag{4}$$

Where: φ_j - the color for the new warped pixel,
φ_i - The weight and
$\Delta\varphi_{ij}$ - The color difference between the pixels.

This procedure is repeated for every pixel in the image and for every image in the morphed image.

Creating composites with only parts of the face being morphed

This is one of an application of morphing technique which shows how to change only certain aspects of a face and leave other features intact. For example, it might be desirable in some studies to change only the eyes or the mouth of a face while

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keeping the rest of the face constant. In such cases, areas need to be specified in which the changes occur [6, 7].

Figure4. The lines for face A that designate parts of the faces that can be morphed separately. Four areas are shown: left and right eyes, nose, and mouth.

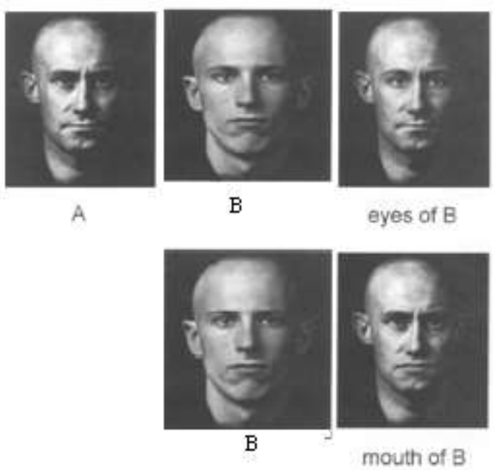

Figure5. Face A has eyes replaced with the eyes of face B or the mouth of B

In Figure 4, areas are specified by segments in which the changes can be occurred (the left eye, the right eye, the nose, and the mouth area). In Figure 5, two examples of this application are shown. In first the eyes of face A are replaced by the eyes of face B and another example shows the mouth area of face A is replaced by the mouth of face B. The slight change in basic morphing program can create such images. For first example, for the areas of the eyes the grayscale values of A and B are weighted averages. Outside the eye areas, the grayscale values of face A are copied as it is.

$$C(\boldsymbol{p_o}) = \begin{cases} \eta\{(1-\alpha)C(\boldsymbol{p_1}) + \alpha C(\boldsymbol{p_2})\} + (1-\eta)C(\boldsymbol{p_1}) \\ C(\boldsymbol{p_1}) \end{cases}$$

if P_0 in eyes area, otherwise.

Image 1 and 2 correspond to images A and B, respectively.

Here, *a* - the contribution of the eyes of A relative to B (between 0 and 1).

η - define the eye area which depends on the distance d_{min} of the pixel P_0 to the nearest segment of the segments

$$\eta = 1 - \exp(-d_{min}/e)$$

Where,

e - determines how fast the cross-dissolving changes from just depending on face A to depending on a weighted average of A and B. This method of changing parts of faces has an important advantage over other approaches. Here, a smoothing process is incorporated to smooth the changes in the cross-dissolving process in which all grayscale values originate either from the source face or from a weighted average of two source images.

Implementation and results

We have divided our work into following steps explained below:

Step 1- Loading of Two Images

1. imread(),
2. Resize the two images if necessary

Step 2- Getting Corresponding Points

1. Edge Detection using Canny Edge Detection
2. Control point extraction
3. Genetic Algorithm for matching of general shapes and segmented areas

Step 3- Warping and creating composites with only eyes of the face A

Step 4- Calculating Performance Parameters for Image A, Image B and Morphed image.

Results:

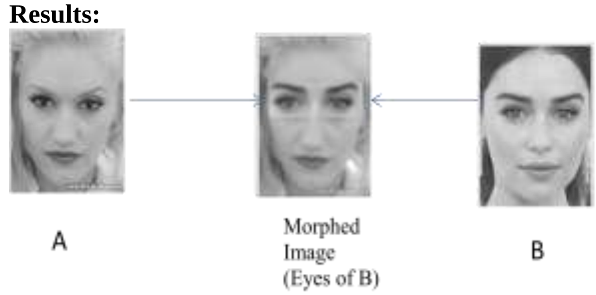

Fig.6 Face A has eyes replaced with the eyes of face B

Observation Table

Parameters	For Image A	For Image B	For Morphed Image
Contrast(c)	0.5149	0.3219	0.4014
Correlation (E)	0.8748	0.7985	0.7708
Homogeneity (D)	0.8555	0.8715	0.8532
Energy	0.1842	0.2345	0.2001

Table I. Variable Constants

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The experimental results show that position of each face component plays a more important role than the homogeneity and color of the face [8].

Conclusion

This paper describes how to use basic morphing algorithm to morph only parts of an image. Control points are extracted automatically, which reduces the parameters that must be inputted by the user. Also the performance parameters to study the Morphing effect on the morphed face image are calculated. One of the areas in this work that need improvement is the color transition algorithm. This work will also be extended to morphing between more than two images

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