HUMAN FACE MORPHING

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ABSTRACT
Image morphing is an important branch of image processing. The transformation of one image in to another smoothly is called as an image morphing. Given two face images, transform one in to other smoothly & as fast as possible. Image morphing has its application in the various areas. Morphing is realized by using image warping with colour interpolation. This method results in very smooth morphs and is fast to process. For automatic control point selection face detection neural network, edge detection and median filter are required.

Keywords - colour interpolation, geometric transformation.

I. INTRODUCTION

Morphing is realized by using image warping with colour interpolation.

Image warping applies 2D geometric transformation on the images to obtain geometric alignment between their features, while colour interpolation blends their colour [1].This method results in very smooth morphs and is fast to process. For automatic control point selection face detection neural network, edge detection and median filter are required. The method of deforming a digital image to different shapes is known as warping.

Early in 1990, Wolberg proposed a mesh warping method [2]. Then in 1992, Berier & Neely proposed a human face image morphing method based on field feature [3]. Ruprecht & Muller proposed an image morphing algorithm based on scatter data interpolation [4] in 1995. Meanwhile, Lee et al. Proposed another method based on multilevel freeform deformations [5] & energy minimization method [6] was proposed by Lee et al. in 1996.

The effective use of morphing is directly related to having the solution for the following problems namely feature specification, warp generation & transition control. The various morphing techniques developed to address these three problems are mesh warping, field morphing, radial basis functions, thin plate splines, energy minimization & multilevel freeform deformations.

Image morphing has its application in the areas like Medical Image processing, Art, Animation, Film & advertising media in television shows, Age progression, Card authentication etc.

II. RESEARCH PROBLEM

In triangle co-ordinate system, the feature points on the first face image are marked & corresponding feature points on second face image are also marked. Then geometric transformation & colour blending are applied to have transformation between first & second face image. We can use this morphed face image in many applications.

To morph one image to another smoothly & as fast as possible, new positions & colour transition rates for the pixels in each of the images in the sequence must be calculated. It involves three processes[7],

i) feature specification
ii) warp generation
iii) transition control.

III. RELATED WORK

1] Cross-dissolve:-

Before the development of morphing, image transitions were generally achieved through the use of cross-dissolves, e.g., linear interpolation to fade from one image to another.

Fig. 1. Cross-dissolve

2] Mesh warping:-

The five frames in the middle row represent a metamorphosis (or morph) between the two faces at both ends of the row. We refer to these two images as IS and IT, the source and the target images respectively.

These meshes are used to warp IS into increasingly deformed images, thereby deforming IS from its original state to those defined by the intermediate meshes. The identical process is shown in reverse order in the bottom row of the figure, where IT is shown deforming from its original state.

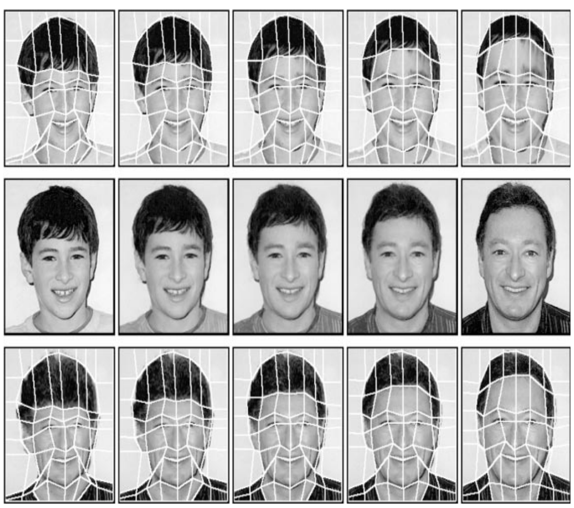

Fig. 2. Mesh warping

The purpose of this procedure is to maintain the alignment of landmarks between IS and IT as they both deform to some intermediate state, producing the pairs of I1 and I2 images shown in the top and bottom rows, respectively. Only after this alignment is maintained does a cross-dissolve between successive pairs of I1 and I2 become meaningful, as shown in the morph sequence in the middle row.

This sequence was produced by applying the weights [1, 0.75, 0.5, 0.25, 0] and [0, 0.25, 0.5, 0.75, 1] to the five images in the top and bottom rows, respectively, adding the two sets together. This process demonstrates that morphing is simply a cross-dissolve applied to warped imagery. The important role that warping plays here is readily apparent in the comparison of the morph sequence.

3] Field morphing:-

A pair of corresponding lines in the source and target images defines a coordinate mapping between the two images. In addition to the straight forward correspondence provided for all points along the lines, the mapping of points in the vicinity of the line can be determined by their distance from the line. Since multiple line pairs are usually given, the displacement of a point in the source image is actually a weighted sum of the mappings due to each line pair, with the weights attributed to distance and line length.

4] Radial basis functions/thin plate splines:-

The most general form of feature specification permits the feature primitives to consist of points, lines, and curves. Since lines and curves can be point sampled, it is sufficient to consider the features on an image to be specified by a set of points. In that case, the x and y components of a warp can be derived by constructing the surfaces that interpolate scattered points.

5] Energy minimization:-

All of the methods just described do not guarantee the one-to-one property of the generated warp functions. When a warp is applied to an image, the one-to-one property prevents the warped image from folding back upon itself. Lee et al. (1996) propose an energy minimization method for deriving one-to-one warp functions.

6] Multilevel free-form deformation (MFFD) based morphing:-

Large performance gains are achieved by applying multilevel free-form deformation (MFFD) across a hierarchy of control lattices to generate one-to-one and C^2-continuous warp function. In particular, warps are derived from positional constraints by introducing the MFFD as an extension to free-form deformation.

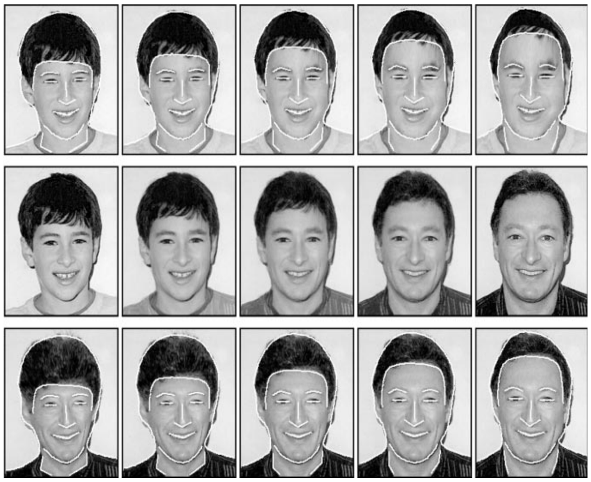

Fig. 3. Multilevel free-form deformation (MFFD) based morphing

IV. MATERIAL AND METHOD

i) Feature specification :-

It defines the control points to be used when the image is being warped. This process in most cases is performed by selecting feature points manually. The choice and number of control points determine how accurately two images can be warped. The use of many control points will usually result in a very good warp.

To focus on the warping of the human face, the selected control points are all within the face region. Five control points as, center of both eyes, tip of the nose and both corners of the mouth.

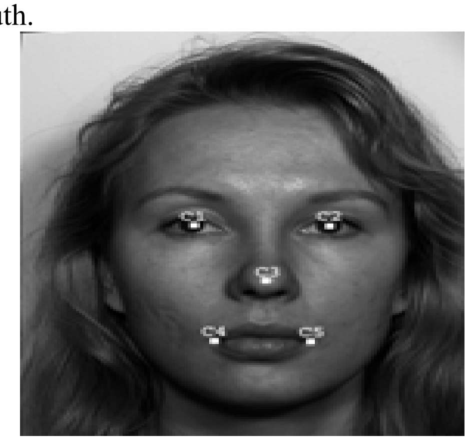

fig.4 Location of the control points.

The choice of these facial points as control points is based on the some of their properties, for example, the distances between them, nose colour is more bright than other face region. Moreover, in given two faces of different sizes these control points can be used to normalize the faces to a given normal size.

The control points from source & target face image are extracted, then these images are ready for warping.

ii) Warp generation :-

It calculates & transforms pixel in one image to new position in the other image. In the triangulation method [8] , the interpolation is achieved by dividing space in to number of triangle with the selected control points beings the corners of the triangle.

For many number of control points, many triangles are possible. To avoid thin, poorly shaped triangles & to find the optimal triangulation Delaunay triangulation method [9] is used.

Control points extraction is performed for both the source and target images. Once these points are found, the images are ready for warping. The source and target images are of the same size, but the faces in them can be of different sizes. The warping method used in this work is triangle based interpolation. The images are divided into several triangles using the control points, There are 32 triangles per image are possible.

Apart from the four corners of the image all the other points are on the edges of the image, that complete the triangles are all related to the five control points. To evaluate the values of these points all that needs to be known is the size of the image. For two corresponding triangles, one from the source image and the other from the target image, the warping transformation from one to the other can be performed.

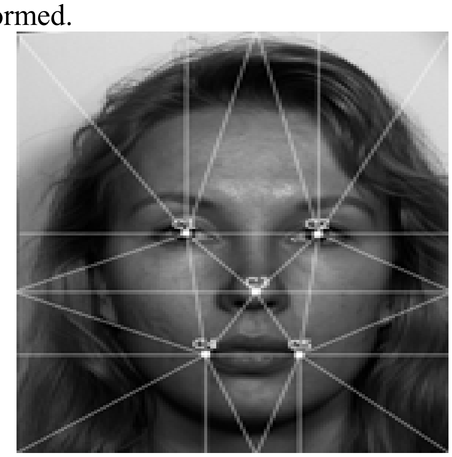

fig.5 Triangles used for warping.

Let points P_1, P_2, P_3 on the source image be located at $x_1=(u_1, v_1)$, $x_2=(u_2, v_2)$ and $x_3=(u_3, v_3)$. Also let points Q_1, Q_2,Q_3 on the target image be located at $y_1=(x_1, y_1)$, $y_2=(x_2, y_2)$ and $y_3=(x_3, y_3)$. The points on the source image can be mapped to those on the target image using eqs. 1 and 2.

$x= a_{11}\, u + a_{21}\, v + a_{31}$ ---------- (1)

$y = a_{12}\, u + a_{22}\, v + a_{32}$ ---------- (2)

By solving ,

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} = \begin{pmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{pmatrix} \begin{pmatrix} u_1 & v_1 & 1 \\ u_2 & v_2 & 1 \\ u_3 & v_3 & 1 \end{pmatrix}^{-1} \quad \text{---------} \quad (3)$$

we get the coefficients a_{11}, a_{12}, a_{21}, a_{22}, a_{31}, a_{32}. Then warping can be done using target to source mapping.

iii) Transition control:-

It determines rate of warping & colour blending across the morph sequence. A morph contains a sequence of intermediate images from the source image to the target image. Colour transition is the method that determines the rate of colour blending across the sequence. The choice of this rate determines the quality of the morphs. The rate of colour blending is usually based on weights.

The weights are calculated by using a one-dimension Gaussian function as,

From target and source pixels, first calculate the difference in colour between them and then set the Gaussian function '1' for the target pixel and to '0' for the source image. The weight for each morph in the sequence is then calculated based on the colour difference calculated before, the value of the Gaussian function at that point and the number of warps in the sequence.

The colour for each image in the morph sequence is then calculate using;

$$\psi_j = \psi_i - w_i * \Delta\, \psi_{ij} \quad \text{---------} \quad (4)$$

Where,

ψ_j be the colour for the new pixel

w_i be the weight &

$\Delta\, \psi_{ij}$ be the colour difference between the target & source pixels.

This procedure is repeated for every pixel in the image and for every image in the morph sequence. The source image changes from the original image, to the new image produced by the first warp and so on.

V. Conclusion and Further Work

To morph between a source (a) and target (o) images, 13 intermediate images (b)-(n) were produced. Notice the smoothness of the face regions. Also note that halfway through the morph, images (h)-(j), faces of completely different persons are created.

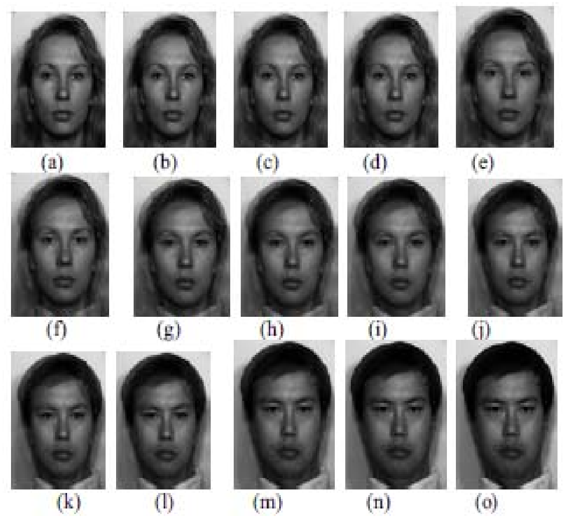

fig.6 Morphing

Information required from the user is the size of the source & target images only. Good result for the face region obtained by using only 5 control points. More control points need to be defined to take care of the hairs & the background.

To improve colour transition algorithm, reduce the number of frames required to complete the morph. Morphing between more than two images can be obtain.

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