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Morphing by Triangulation Method

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Abstract: *Image metamorphosis or morphing for short, is commonly referred to as the animated transformation of one digital image to the other. Image morphing finds numerous applications in many fields including computer vision, animation, art and medical image processing. Morphing involves the image processing techniques of cross-fading and warping to morph one image into a completely different image. Morphing software allows a step by step transformation from one image into another. The most difficult one is wrapping of one image into another image. It is the stretching and pulling of the images, that makes morphing effects so realistic.*

Keywords: *Genetic algorithm, Warping, Color transition, Interpolation, Image morphing.*

I. INTRODUCTION

The actual morphing of the images can be accomplished either by using morph points or morph lines. Morph points are the markers that you set up on the start image and the end image. The morphing program then uses these markers to calculate how the initial image should bend/warp to match the shape of the final image. The second method is lines instead of individual points. Both methods produce very realistic morphing image. Image warping can be defined as a method for deforming a digital image to different shapes. Practically, this can be simulated using an image drawn on an elastic surface. By moving the corners of the elastic material to new positions, the image will deform accordingly. Image morphing combines image warping with a method that controls the color transition in the intermediate images produced. To morph one image to another, new positions and color transition rates for the pixels in each of the images in the sequence must be calculated. The image morphing involves three processes:

- (1) Feature specification,
- (2) Warp generation and
- (3) Transition control [1].

II. RELATED WORKS

Over the years, many methods have been proposed to perform image morphing. Of these, the following are worth mentioning. Triangulation based methods achieve interpolation through a triangulation of control points by first dissecting the defining space into a number of triangles with the given control points being the corners of the triangle. Each of the resulting triangles is then interpolated independently [2]. Obviously, given any number of control points, many triangulations are possible. To avoid thin, poorly shaped triangles and therefore find the optimal triangulation, Delaunay triangulation [3] is commonly used.

Field morphing handles correspondence by means of line pairs. A line of corresponding lines in the source and target images defines a coordinate mapping between two images, [4]. The Shepard approach of scattered data uses a weighted average of the data values at the data points, with weights dependent on the distance of the points from the given control point, [5].

Other methods include the radial basis functions, nearest neighbor interpolation, inverse distance weighted method etc. A recent comprehensive study of these methods is available in [6].

III. MORPHING

Proposed Design

The complete details about the proposed morphing approach are outlined here. This is completely aligned in three sections. They are:

- Control Points Extraction
- Warping
- Color Transition

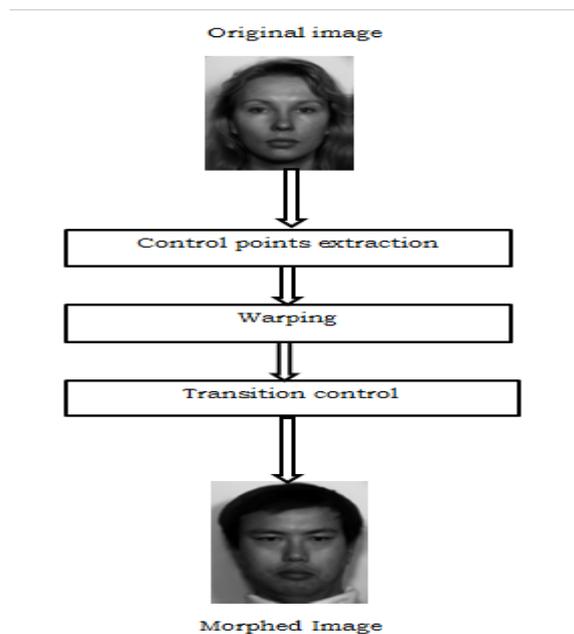


Fig 1: Flow chart of Image morphing

A. Control points Extraction

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. However a high number of control points will reduce the speed of the system since the number of triangles increase, which in turn increases the computation time. Given an image, this work focuses on the warping of the human face. Therefore, the control points selected are all within the face region as shown in Fig.

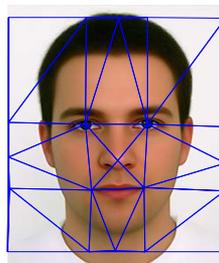


Fig 2: Control points Extraction

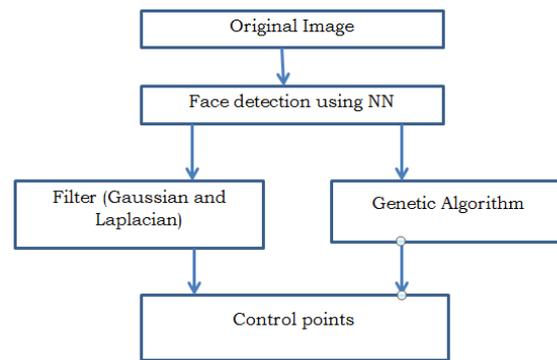


Fig 3: Flow diagram of control point selection

B. Warping

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 triangles based interpolation. The images are divided into several triangles using the control points already found.

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. Let points P1, P2, P3 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 Q1, Q2, Q3 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 equations,

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

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

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

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

Warping can then be done using target to source mapping.

C. Transition control

A morph contains a sequence of intermediate images from the source image to the target image. Color transition is the method that determines the rate of color blending across the sequence. The choice of this rate determines the quality of the morphs. Interesting morphs can be created depending on whether the color-blending rate changes locally or globally. The rate of color blending is usually based on weights. Such weights are selected to smoothly complete the transition between the images on the sequence. In this paper, the weights are calculated using a one-dimension Gaussian function. This method is implemented as follows:

Given two corresponding target and source pixels. First, calculate the difference in color 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 color difference calculated before, 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 calculated using;

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

Where: ψ_j is the color for the new warped pixel, ψ_i is the weight and ψ_{ij} is the color difference between the target and 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.

IV. SIMULATION RESULTS

BY MESH MORPHING

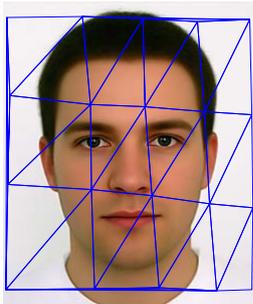


Fig. 4 Mesh on source image

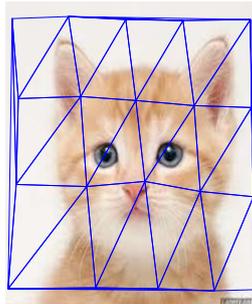


Fig. 5 Mesh on target image



Fig. 6 Morphed image

Morphed frames via Mesh Wrapping



Fig. 7 Mesh Morphing Frames

TRIANGULATION MORPHING

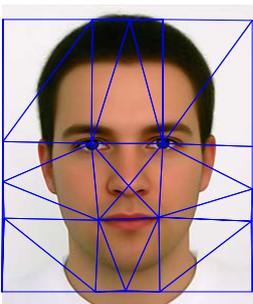


Fig. 8 Triangle net on source image

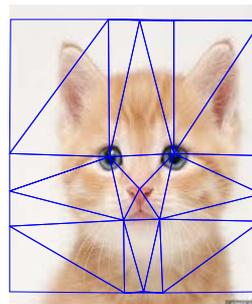


Fig. 9 Triangle net on target image



Fig. 10 Morphed image

Morphed frames via triangulation wrapping



Fig. 11 Trianleg Morphing Frames

TABLE I

Comparison of results obtained in mesh morphing and triangle morphing

Parameter	Mesh morphing	Triangle morphing
MSE	241.4560	9.8248
PSNR	48.6048	76.4151

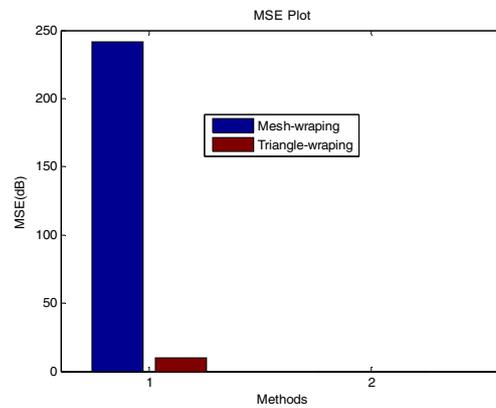


Fig. 12 MSE plot for mesh morphing and triangle morphing

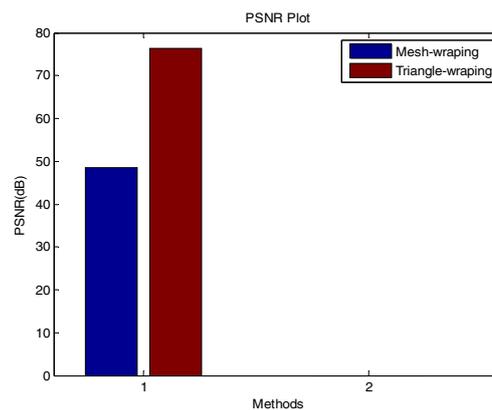


Fig. 13 PSNR plot for mesh morphing and triangle morphing

The above figure represents the PSNR plot in these we are taking two methods previous method as well as proposed method. The previous method called mesh warping and the proposed method called triangle warping, compare to the mesh warping the triangle warping has more accurate PSNR. Mesh warping of PSNR value is 48.6048 and triangle warping of PSNR value is 76.2937.

V. CONCLUSION

The PSNR value for triangular warping is higher than that of Mesh warping. The proposed method called triangle warping, compare to the mesh warping triangle warping has more accurate PSNR. The results show that the triangulation morphing method produces smooth morphs than mesh morphing.

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