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Improved Mesh_Based Image Morphing

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Abstract

Image morphing is a multi-step process that generates a sequence of transitions between two images. The thought is to get a grouping of middle pictures which, when assembled with the first pictures would represent the change from one picture to the other. The process of morphing requires time and attention to detail in order to get good results. Morphing image requires at least two processes warping and cross dissolve. Warping is the process of geometric transformation of images. The cross dissolve is the process interpolation of color of each pixel from the first image value to the corresponding second image value over the time. Image morphing techniques differ from in the approach of image warping procedure. This work presents a survey of different techniques to construct morphing images by review the different warping techniques. One of the predominant approaches of warping process is mesh warping which suffers from some problems including ghosting. This work proposed and implements an improved mesh warping technique to construct morphing images. The results show that the proposed approach can overcome the problems of the traditional mesh technique.
Keywords: Warping, cross dissolve , mesh warping, morphing

الخلاصة

تحويل الصورة هي عملية متعددة الخطوات تلك التي تولد سلسلة من الانتقالات بين صورتين. والفكرة هي الحصول على سلسلة من الصور الوسطية التي عند وضعها جنبا إلى جنب مع الصور الأصلية من شأنه أن يمثل التغيير من صورة واحدة إلى أخرى. عملية التحول تتطلب وقت واهتمام بالتفاصيل من أجل الحصول على نتائج جيدة. تحول الصورة يتطلب عمليتين على الأقل هما التشويه والتداخل. التشويه هو عملية التحول الهندسي للصور، في حين عملية التداخل تمثل تداخل لون كل بكسل على مر الوقت من قيمة الصورة الاولى الى ما يقابلها من قيمة الصورة الثانية. تقنيات تحول الصوره تختلف في الاسلوب عن اجراء تشويه الصورة. هذا العمل يقدم دراسة لتقنيات مختلفة لبناء تحول الصور عن طريق استعراض تقنيات تشويه مختلفة. واحد من الاساليب السائده لعملية التشويه هو التشويه الشبكي الذي يعاني من بعض المشاكل بما في ذلك الظلال. هذا العمل المقترح ينفذ لتحسين تقنية التشويه الشبكية لبناء الصور المتحولة. وتبين النتائج أن الأسلوب المقترح يمكنه التغلب على مشاكل تقنية الشبكة التقليدية.
الكلمات المفتاحية: التشويه , التداخل, التشويه الشبكي, التحويل

1. Introduction

Morphing is gotten from the term Metamorphosis which implies change in object form (Bhatt *et al.*, 2011). Image morphing used in a lot of applications in many fields including computer vision, animation, art and medical image processing (Karungaru *et al.*, 2007).Image morphing requires two processes image warping and cross dissolve. Morphing sequences created by just utilizing cross-dissolving (e.g. linear interpolation to fade from one image to another) of the source and goal image are visually poor. The cause of the poor results is the features of the source and destination will not be aligned. When we simply cross dissolve, the ghosting effect will be apparent in misaligned regions. In order to overcome this problem, warping is used to align the two images before cross dissolving. Warping determines are the ways in which the pixels in one image should be mapped to the pixels in the other image. For warping to work, the mapping of a few important pixels needs to be specified. These pixels are called the control points. The motion of the other pixels is obtained by extrapolating the information specified in the control pixels. Since cross dissolving is very simple, warping becomes the major problem of morphing techniques. Morphing is simply a cross-dissolve applied to warped image. The different warping techniques differ in the way the mapping for the control pixels are to be specified and the interpolating technique used for the other pixels. These groups of control pixels usually specify prominent features in the images (Oswal *et al.*, 2013).

Many techniques are suggested to construct morphing images. All these techniques depend on the appropriate control points that are used to align the source and destination images to gain the expected results. These control points are considered as parameters that need to be adjusted. The adjustment of these parameters is not an easy or direct task. It requires trail and error, manual adjustment of the human to determine some control points. The next sections will explain some of these techniques.

One of the predominant approaches of warping process is mesh warping which suffers from problems such as ghosting and misalignment of the control points of the source image and the destination image to the landmarks of the images. This work proposed and implements an improved mesh warping technique to construct morphing images. The proposed approach uses API functions to move the specified control point to match the alignment between the control points of source and destination images to the required landmarks. The results show that the proposed approach can overcome the problems of the traditional mesh technique and reduces the ghosting effect to the minimum.

The rest of the paper is organized as follows: section 2 presents the general stages of morphing image construction, section 3 presents the different techniques of image warping, section 4 presents the proposed morphing technique and results, finally, the conclusion are presented in section 5.

2. Image Morphing

One of the most powerful Digital Images processing technique, is the image morphing which is used to improve many multimedia projects, presentations, education and computer based training. In medical imaging, image morphing, which is used to recover features not visible in images by establishing a correspondence of features ,among successive pair of scanned images. Image morphing consists of two major stages, image warping (changing the position of key features in the images) merged with cross-dissolving as shown in Figure 1.

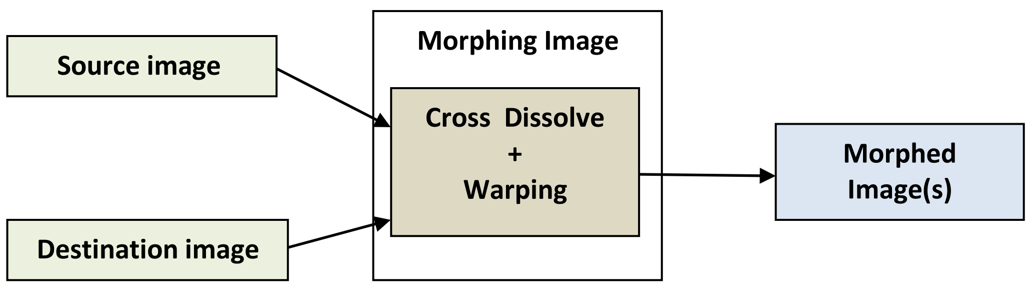


Figure-1 (Morphing Image)

2.1 Cross Dissolving Process

Before morphing development, transitions between two images were generally done by cross dissolving (e.g. a linear color morphing interpolation to fade from one image to another). A cross dissolves is usually applied to the whole image and in effect the texture of the source image is transformed to the texture of the goal image by blending the color of the pixels. The cause of poor results is the double exposure effect that is apparent in regions where the features of the source image do not align with those in the goal image as seen in Figure 2 (P. K. Oswal,et.al,2013) .

Figure-2 (Example of Cross Dissolve Process)

2.2 Warping Process

Geometric transformation of digital images is part of image warping. A warp can range from a simple translation, rotation or scale. In image processing, warping is usually done to remove the distortions from an image (correcting geometric distortions), while in computer graphics it is used to introduce distortions. In image morphing, warping is used to align the key features (e.g. eyes, mouth, and nose) of the two images being morphed. A warp defines a geometric relationship between each point in the source image and each point in the goal image. In other words, a two dimension warping is a transformation that distorts a two dimensions source space into a two dimension destination space - it converts a source point [u,v] to a destination point [x, y], as illustrated in Figure 3 (Karungaru *et al.*, 2007) .

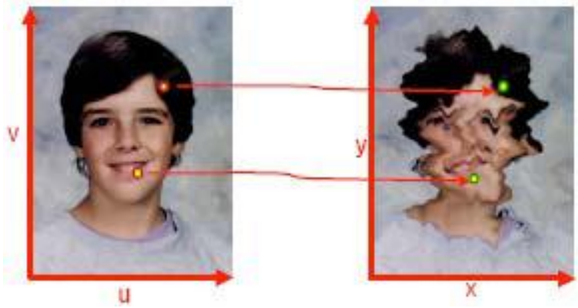


Figure-3(Image Warping Process)

The general warping function can be written as

$$[x, y] = [X(u,v), Y(u,v)] \quad \text{.........(1)}$$

or it can be expressed as

$$[u, v] = [U(x, y), V(x, y)] \quad \text{.........(2)}$$

that relating the input coordinate system to that of the output. Here [u, v] refers to the input coordinate corresponding to the output coordinate [x, y] and X, Y, U and V are warping functions that specify the spatial transformation. The functions X and Y convert the input into the output and therefore (1) is referred to as forward warping. The functions U and V convert the output to the input and (2) is known as reverse warping.

3. Image Morphing Techniques

Morphing involves the image processing techniques of warping and cross dissolving. Warping is the major stage of morphing techniques because the quality of morphed images is based on the accuracy of aligning the control points between source and goal images. Warping techniques differ in the way the control points is to be specified and the interpolating technique used for the other pixels.

3.1 Mesh Warping

The mesh is one of the most traditional technique of warping technique. In this technique as shown in Figure 4, the source image I_s is associated with mesh M_s. It specifies the coordinates of control points, or landmarks. A second mesh M_d specifies their corresponding positions in the destination image I_d. The landmarks such as the eyes, mouth, and lips must lie below the corresponding grid lines intersection in both meshes. Both of the M_s and M_d are used to define the spatial transformation that converts all points in I_s onto I_d. The meshes are constrained to be topologically equivalent, i.e., no folding or discontinuities are permitted. Therefore, the nodes in M_d may wander as far from M_s as necessary, as long as they do not cause self-intersection. The major problem with mesh warping technique is the difficulty to fit the mesh in images that the landmark of the source and destination images may not lie under the intersection of the lines of the grid. The second problem with this technique is that the control points which are represented by the intersection of the grid lines may not enough in certain areas when needed.

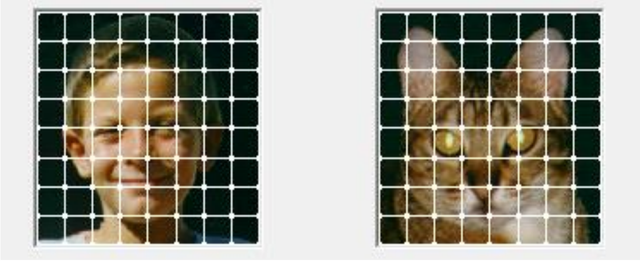


Figure-4 (Mesh technique)

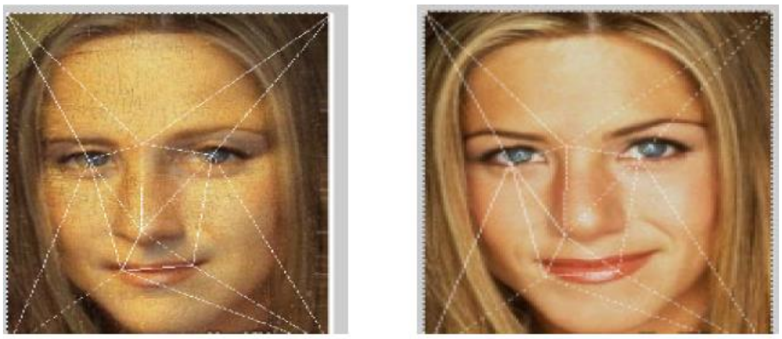
Figure 5 shows the result of applying the Mesh Based Image Warping technique to construct the morphed images.

Figure-5 (Example of Applying Mesh Warping Technique)

The cause of poor results is the features of the source image do not align with those in the destination image.

3.2 Triangulation-Based Warping Technique

This technique consists of first dissecting the definition space into a reasonable groups of triangles with the given data points at the corners of the triangles. After that, each of the triangles is interpolated autonomously. A few criteria for an ideal triangulation are known. To avoid thin triangles, delaunay triangulation maximizes the minimum inner angle of all triangles. It can be processed with a divide-and-conquer algorithm of complexity O (n log n) where n is the number of data points. A common problem to all images warping techniques based on triangulation methods is that fold over can easily occur. Fold over is described by the occurrence of overlapping deformations, that is, several nonadjacent pixels in the input image are mapped to the same pixel in the output image. With triangulation-based methods, this happens if the orientation of the corner points changes for any of the triangles, that is, the triangle is flipped over by the deformation. Figure 6 shows the result of applying Triangulation Morphing with 6 feature points to construct the morphed images (M. B. G. Bhatt,2011).



Source image Destination image

Figure-6 (Example of Applying Triangulation_Based Morphing)

3.3 Feature Based Image Warping

This technique gives the animator a high level of control over the warping process. The illustrator intuitively chooses to relate highlight lines in the source and goal pictures to be transformed. As shown in Figure-7, lines used by the algorithm to relate features in the source image to features in the destination image. It depends on fields of influence surrounding the feature lines selected. For warping the image ,it utilizes turn around mapping (i.e. it goes through the destination image pixel by pixel, and samples the correct pixel from the source image). Two lines are defining for a mapping from one image to the other (one defined relative to the source image, the other defined relative to the destination image) and many calculated geometric parameters ((M. B. G. Bhatt,2011).

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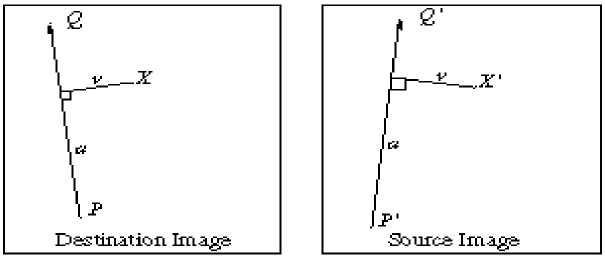


Figure-7 (lines features in the source image and the destination image)

Figure 8 shows the result of applying the Feature Based Image Warping technique to construct the morphed images.

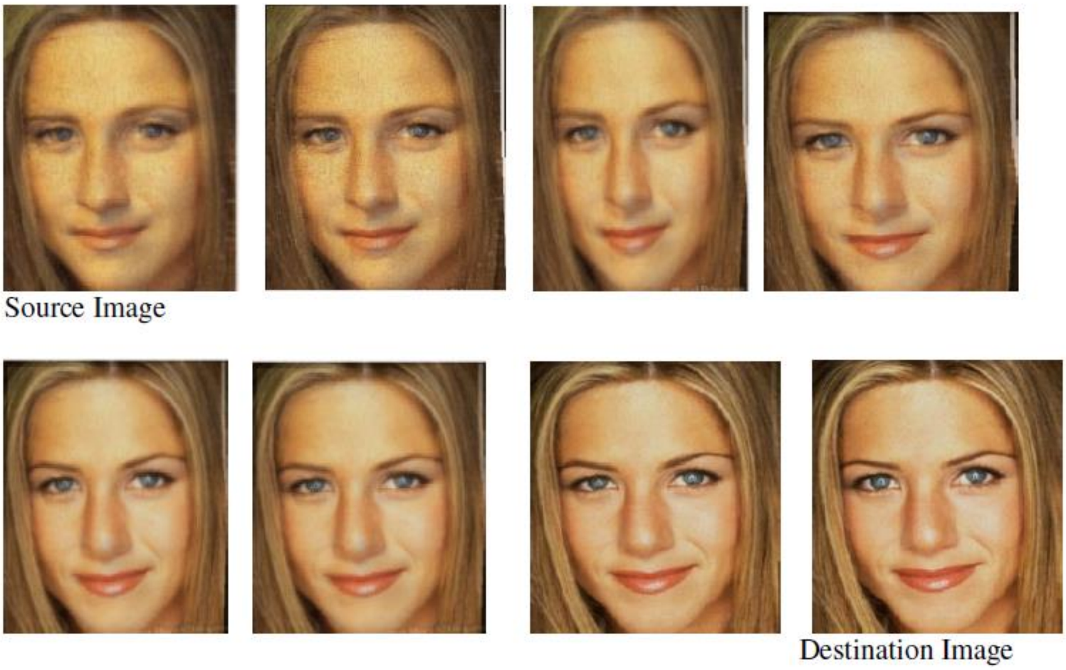


Figure-8 (Example of Applying Feature_Based Morphing)

3.4 Thin Plate Spline (TPS) Based Image Morphing

It is a conventional technique for surface interpolation over scattered information. It is an interpolation method that finds a insignificantly twisted smooth surface that goes through every single given point. The name "Thin Plate" originates from the way that a TPS pretty much reproduces how a thin metal plate would carry on the off chance that it was constrained through a similar control points. Figure 9 demonstrates a straightforward case of facilitating change utilizing TPS (Oswal *et al.,* 2013; Feciorescu, 2010).

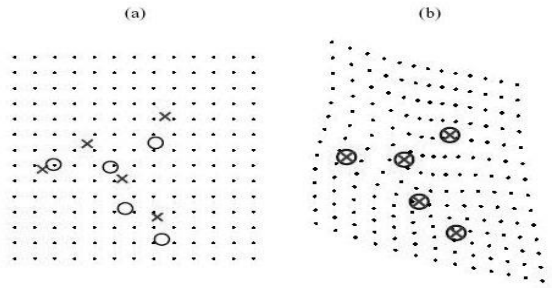


Figure-9 (TPS Based Warping Technique)

Figure10 shows an example of applying the TPS Based Image Warping technique to construct the morphed images ((P. K. Oswal,et.al,2013).

Figure-10 (Example of Applying TPS_Based Morphing)

3.5 Snakes Warping Technique

In this method snakes (Active Contour Models), a popular technique in computer vision, are used to specify features in the source and destination images The utilization of snakes depends an extraordinary arrangement of the elements in a picture being all around characterized by their edges. To determine an element, a snake is introduced by positioning a polyline (connected control points) close to a feature. A sequence of points is then uniformly sampled on the polyline. Figure 11 illustrates an example where (a) is the image with the rough manually specified connected control points and (b) is the same image after the snake has been applied to the linked control points (Delport,2007) .

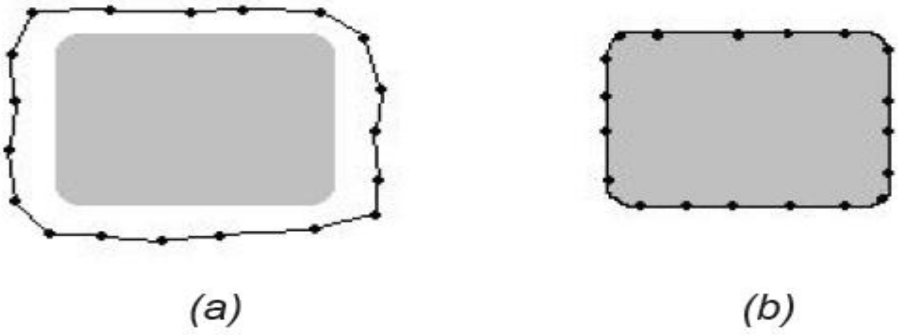


Figure-11 (Example of Snake Warping Technique)

Figure 12 shows an example of applying Snake Based Image Warping technique to construct the morphed images (G. Wolberg,1996).

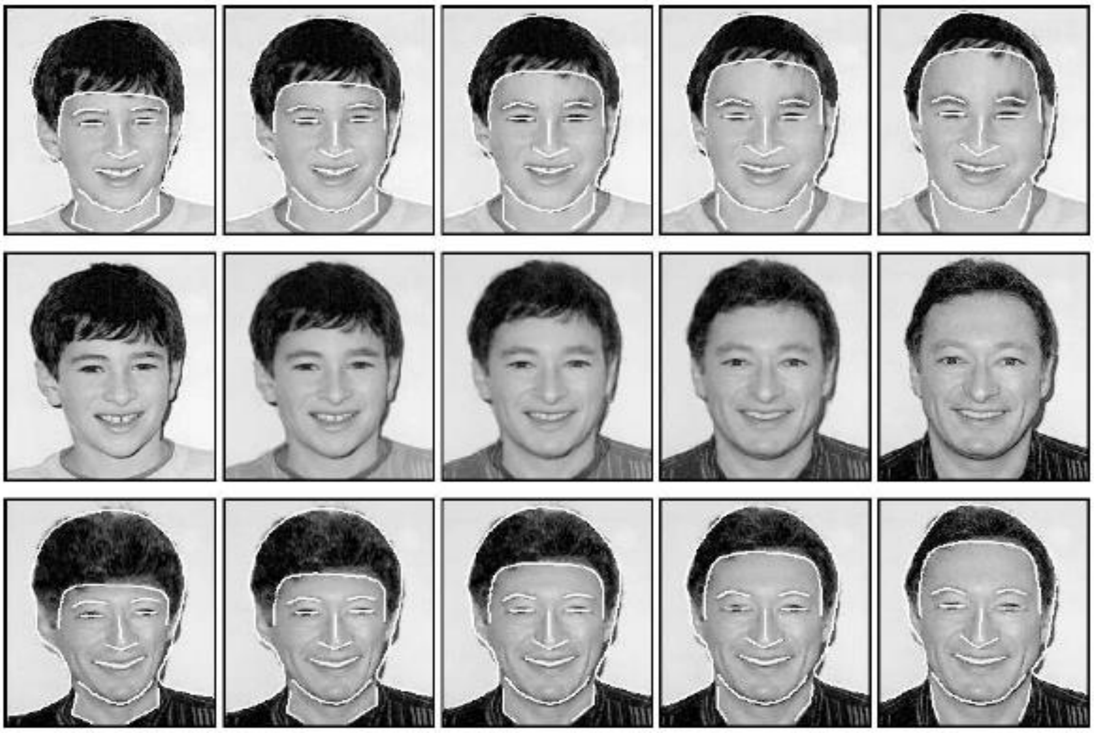


Figure-12 (Example of Applying snake_Based Morphing)

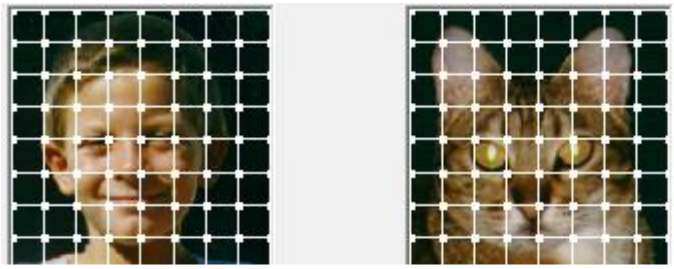
4. The proposed improvement of Mesh_based morphing image

This paper proposes an improvement to mesh approach. As it was mentioned previously, mesh warping technique may suffers from the problems of miss alignment of the control points to the landmarks and there may be no enough control points to specific areas.

The proposed method is based on the mesh technique, the source image Is is related with mesh Ms. It indicates the coordinates of control points. A second mesh M_d indicates their corresponding positions in the destination image I_d. the number of the control points to generate mesh is specified by the animator. The mesh of size

N*M means N control points in the row and M control points in the column as shown in the Figure 13.

In the traditional mesh warping technique, the landmarks such as the eyes, nose, and lips may or may not lie below the corresponding grid lines intersection in both meshes. This work overcomes this problem by allowing the animator to move the control points lie exactly on the specified landmark as shown in Figure 14.



(a) (b)

Figure-13 (a-Is is associated with mesh Ms, b- Id is associated with mesh Md)

Figure-14 (Manually Moved Control points of the source and Destination Images)

Then, it is possible to apply the cross dissolve stage between the control points of the source and destination image and interpolate other pixels to produce the morphed image. The number of the intermediate morphed images is specified by the animator. The following algorithm shows the steps of morphed Image construction using the proposed improvement of mesh warping technique.

Improved Mesh Morphing Algorithm
Input: Source image I_s, Destination image I_d,
The size of the mesh N*M
The Number F of the Intermediate Morphed Images
Output: Morphed image

Step 0 : Divide each image into mesh with N*M control points.
Step 1 : Manually, move the control points to be laid on the required landmarks.
Step 3 : For each frame F do
Linearly interpolate mesh between M_s and M_d
Linearly interpolate image I_f, between I_{f-1} and I_d
Step4 :End.

Figure 15 shows the result of applying the proposed morphing technique.

Input image

Output image

Figure-15 Example of applying the Improved Mesh Morphing Algorithm

5. Conclusions

This work proposes and implements an improved mesh warping technique to construct morphing images. The results show that the proposed approach can overcome the problems of the traditional mesh technique of misalignment of the control point and the landmarks of the source and destination images. This problem leads to the effect of ghosting, which is consider the most important criteria to discriminate among the different morphing image construction approaches. All the morphing image approaches try to reduce the effect of ghosting. The results of applying this proposed technique show there is no ghosting in the intermediate morphed images.

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