Image Morphing: A survey

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***Abstract*-Image morphing deals with the metamorphosis of an image to another image. The metamorphosis generates a sequence of in between images in which an image gradually changes into another image over time. The idea is to get a sequence of intermediate images which when put together with the original images would represent the change from one image to the other.The problem of image morphing is basically to generate an in-between image from two given images. A natural in-between image can be derived by properly interpolating the positions of features between two images and their shapes and colors. An image morphing technique first establishes the correspondence of features between two images. The correspondence is then used to compute warps for the images so that the distorted images match the positions and shapes of features. A cross-dissolve of colors at each pixel of the distorted images finally gives an in-between image**.

***Keyword*-Image morphing, Feature Specification, Warp generation, Cross Dissolve, Transition control**

I. INTRODUCTION

Morphing is achieved by coupling image warping with colour interpolation. As themorphing proceeds, the source image is gradually distorted and is faded out, while the target image is faded in [1, 3]. So, the early images in the sequence are much like the first image. The middle image of the sequence is the average of the first image distorted halfway towards the second one and the second image distorted halfway back towards the first one. The last images in the sequence are similar to the second one. Then, the whole process consists of warping two images so that they have the same "shape" and then cross dissolving the resulting images.

Image morphing techniques have been widely used in creating special effects for television commercials, music videos such as Michael Jackson's Black or White[l], and movies such as Willow and Indiana Jones and the Last Crusade [2]. The problem of image morphing is basically to generate an in between image from two given images[l]. A natural in between image can be derived by properly interpolating the positions of features between two images and their shapes and colors. An image morphing technique first establishes the correspondence of features between two images. The correspondence is then used to compute warps for the images so that the distorted images match the positions and shapes of features. A cross-dissolve of colors at each pixel of the distorted images finally gives an in between image. A warp is a two-dimensional geometric transformation and generates a distorted image when applied to an image. The most difficult part of image morphing is obtaining a warp which provides a necessary distortion of an image. A warp is usually derived from the correspondence of features specified by an animator.

Therefore, an image morphing technique must be convenient in specifying features and show a predictable distortion which reflects the feature correspondence. In mesh warping [2], features are specified by a no uniform control mesh, and a warp is computed by a spline interpolation. Nishita et al. [3] also used a no uniform control mesh to specify features and computed a warp using a two-dimensional free form deformation and the Bdzier clipping. Feature-based morphing[l] specifies features with a set of line segments and computes a warp by taking weighted average of the influences of line segments. Mesh warping including Nishita's method shows a good distortion behaviour but has a critical drawback in specifying features. They always require a control mesh on an image while its features may have an arbitrary structure. Feature-based morphing gives an easy-to-use and expressive method in specifying features but suffers from unexpected distortions referred to as ghosts[l].

II.MORPHING ALGORITHM

At very first image morphing achieved by simple cross dissolve of two images. The result of simple cross dissolve is very poor having double exposure effect .This problem is particularly apparent in the middle frames. In this section, we review several morphing algorithms including those based on mesh warping, field morphing, energy minimization, and multilevel free-form deformation.

A. Cross Dissolve

Before the development of morphing, transitions between two images were generally done by cross dissolving (e.g. a linear colour interpolation to fade from one image to another). A cross dissolve is usually applied to the whole image and in effect the texture of the source image is transformed to the texture of the destination image by blending the colour of the pixels[8, 20]. The result is poor because of the double exposure effect that is apparent in regions where the features of the source image do not align with those in the destination image.

Fig.1 Cross Dissolve [8] between two images

B. Mesh Warping

Mesh warping was trailblazer at Industrial Light and Magic (ILM) byD. Smythe. It can be described as follows: Consider two image – the source image denoted as I_s and destination image as I_d. Each image has a mesh overlay. The source image has mesh Ms overlaid and the destination image has mesh M_d overlaid. Ms specifies the coordinates of the control point in is and M_d specifies their corresponding position in Id. Ms and M_d are used to determine the spatial transformation that maps all the point in Is onto the points in Id. No folding or discontinuities are allowed in the meshes and for simplicity they are constrained to have frozen outer borders [20].

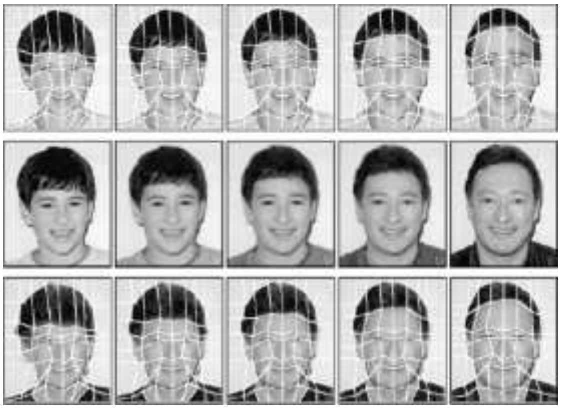

Fig .2 Mesh warping [8] between two images

C. Field Morphing

The field morphing algorithm developed by Beier and Neely at Pacific Data Images grew out of the desire to simplify the user interface to handle correspondence by means of line pairs.A pair of corresponding lines in the source and target images defines a coordinate mapping between the two images [12,13]. 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.

Although this approach simplifies the specification of feature correspondence, it complicates warp generation. This is due to the fact that all line pairs must be considered before the mapping of each source point is known. This global algorithm is slower than mesh warping, which uses cubic interpolation to determine the mapping of all points not lying on the mesh.

D. Snakes and Multilevel Free-Form eformation

In this technique snakes, a popular technique in computer vision, are used to specify features in the source and destination images. Snakes are energy minimizing splines that move under the influence of image and constraint forces. They simplify feature specification because primitives must only be positioned close to the features. Image forces push the snake towards salient image features such as lines and edges while constraint forces pull the snake to a desired image feature among nearby ones, thereby refining their final positions and making it possible to capture the exact position of a feature. The use of snakes relies a great deal on the features in an image being well defined by their edges [17]. To specify a feature a snake is initialized by positioning a polyline (connected control points) close to a feature. A sequence of points is then uniformly sampled on the polyline. As the snake minimizes its energy it wriggles itself and finally locks onto the feature.

E. 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 [8, 16]. Their method allows extensive feature specification primitives such as points, polylines, and curves. Internally, all primitives are sampled and reduced to a collection of points. These points are then used to generate a warp that is interpreted as a 2D deformation of a rectangular plate. The requirements for a warp are represented by energy terms and satisfied by minimizing their sum. The technique generates natural warps since it is based on physically meaningful energy terms. The performance of the method, however, is hampered by its high computational cost.

F. Transition Control

Transition control determines the rate of warping and colour blending across the morph sequence. If transition rates differ from part to part in between images, more interesting animations are possible. Such non uniform transition functions can dramatically improve the visual content. Note that the examples shown thus far all use a uniform transition function, where by the positions of the source features steadily move to their corresponding target positions at a constant rate.

Transition control is setting up the rate at which warping and colour blending takes place during a morph sequence is called the transition control [18, 19]. Most of the morphing techniques discussed above make use of a uniform transition rate - this means that the positions of the features in the source image changes to their corresponding destination positions at a fixed, constant rate. When the transition rate is different from part to part for in-between images in a morph sequence, interesting results can be expected. Such non-uniform transition functions can improve the visual effect of the morph. In mesh-based techniques transition control is achieved by assigning a transition curve to each mesh node. This can be difficult when complicated meshes are used to specify features. The transition speed can be defined by a Bezier function defined on the mesh. Other techniques use a deformable surface model to manage transition control by selecting a set of points on an image and specifying a transition curve for each point.

G. Polymorph

Image metamorphosis has proven to be a powerful visual effects tool. Many breathtaking examples now appear in film and television, depicting the fluid transformation of one digital image into another. This process, commonly known as morphing, couples image warping with color interpolation. Image warping applies 2D geometric transformations on images to align their features geometrically, while color interpolation blends their colors. Traditional image morphing considers only two input images at a time—the source and target images. In that case, morphing among multiple images involves a series of transformations from one image to another. This limits any morphed image to the features and colors blended from just two input images. Given morphing's success using this paradigm, it seems reasonable to consider the benefits possible from a blend of more than two images at a time. For instance, consider generating a facial image with blended characteristics of eyes, nose, and mouth from several input faces. In this case, morphing among multiple images involves a blend of several images at once—a process we call polymorphingcolor.

III. APPLICATIONS

Image morphing has traditionally been associated with visual effects for entertainment. Visually compelling fluid transformations are created by synthesizing intermediate images between supplied image pairs. The basis for these results is attributed to the geometric alignment that is maintained throughout the image sequence. This same result applies to other domains where image interpolation can benefit from supplied geometric correspondence.Although intermediate slices can be computed with conventional linear, cubic, or higher degree interpolation functions, this traditional approach does not consider the underlying structure of the imaged organs. Superior results are made possible by establishing geometric correspondence of features among successive pairs of scans.

In the medical profession, with modern CRT or NMR scans, slices of the human body can be imaged and combined into 3D models. The distance between such slices is usually much larger than the spatial resolution within each slice. For rendering (especially direct volume rendering) and surface reconstruction, this is undesirable as these require the volume elements to have edges of the same length. To achieve this some interpolation between slices is necessary. A method using image morphing to create the intermediate images between key frames is discussed in [18, 19]. Figure 2.4 displays an example where (b) looks much more realistic than (a), because in contrast to (a), the stack of images in (b) is interpolated.

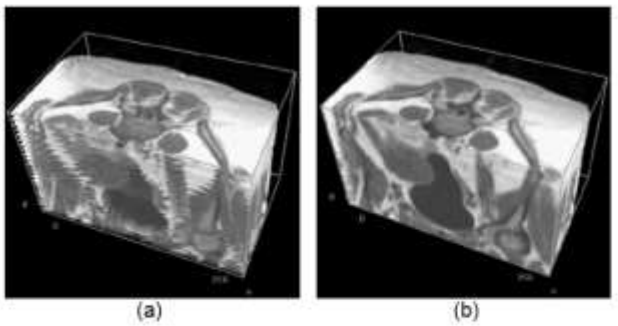

Fig. 3 Volume representation of a stack of images (a) without and (b) with interpolated images [18]

There exist certain classes of images which contain some sensitive areas. For example, when transforming one image of a human face into another, each of the interpolated frames should retain the important elements of the face (eyes, mouth, and nose). Morphological median doesn't allow to point and specify particular objects in the image. In order to control the behaviour of these sensitiveareas control points must be applied. They point at the sensitive areas and ensure that these areas of both input images will not disappear within the interpolation sequence. The behaviour of control points is controlled by a warping technique. Mesh-warping mustbe performed before the morphological median is computed. With the two already mentioned sets of control points and both images, a warped morphological median is produced. This new kind of median represents in fact "classic" morphological median. The difference isthat input images for this median are not the two "pure" initial images, but warped initial images.

The bilinear warping method is based on control points, placed in the nodes of the quadrilateral grid. Each of the control points has two positions: on the initial and on the final image. Warping algorithm converts an initial color image in such a way that the control points change their position from the initial to the final one. Value of all the other image points is recalculated using bilinear transformation.

The proposed method is based on recalculation of coordinates. For each point of final quadrilateral the coordinates of appropriate point from initial one are calculated. The value of the point from initial quadrilateral is copied into the final image. Whenthe final quadrilateral is larger than the initial one, the content must be enlarged. The enlargement can cause problems which are typical for this kind of operation, like e.g. blocky appearance of enlarged parts of the image. They arise due to the necessity of copying a value of a pixel from initial image into more than one pixel on the final image - result of the conversion of real coordinates into integer ones. In order to solve this problem a bilinear interpolation has been applied. The value of a pixel at the final image is linearly interpolated using the values of four closest, known pixels on the initial image and the distances to these pixels. The application of bilinear interpolation into bilinear warping solves the problem of blocky appearance on the enlarged areas and improves linearity and smoothness of contours.

IV. CONCLUSIONS

We have seen there are different algorithms by which image morphing achieved.Morphing algorithms all share the following components: feature specification, warp generation, and transition control. The ease with which an artist can effectively use morphing tools is determined by the manner in which these components are addressed. The earliest morphing approach was based on mesh warping.The field morphing approach attempted to simplify feature specification with the use of line pairs to select landmarks. Warp generation has consequently become formulated as a scattered data interpolation problem. Transition control determines the rate of warping and color blending across the morph sequence. If transition rates differ from part to part in in-between images, more interesting animations are possible. The techniques used to compute warp functions can also be applied for transition control functions, thereby propagating that information everywhere across the image.

V. FUTUREWORKS

Most of the morphing techniques discussed and implemented require a great deal of input from the user. The user is required to define the corresponding control points. The result of this is that a large deal of the quality is dependent on the user. If the user does a good job, then the resulting morph will be pleasing, however if the user does a bad job then no matter how optimal the algorithmimplementation, the resulting morph will not be pleasing. A method to optimally automate this process still needs to discover. Perhaps a technique combining some sort of automated edge-detection with a minimum or no user input.

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