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Simple Application Cases of Morphing Method using Geo-spatial Data

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Abstract : Morphing method, one of classic image processing algorithms, has been used in various application fields. The motivation of this work is to investigate its applicability in consideration to geo-spatial data including airborne or space-borne images. For this purpose, the Beier and Neely morphing algorithm is tentatively implemented in the form of a prototype with user interface. As the results, this feature-based morphing with paired image sets can be used for general users: image simulation using two or more images and construction of color-blending image between source image and destination image in different types. Some simple application cases were demonstrated. This scheme is the simple and useful approach for those who want to utilize both geo-spatial data sets and airborne/space-borne image sets.

Key Words : Color-blending, Frame Images, Morphing, Warping.

1. Introduction

Morphing is an image processing technique used for the metamorphosis between two source images. This technique has been known to be the efficient one to construct facial effects: the aged face generating of a missing child, the composite imaging of two faces, or the extracting of a masked burglar's face. Also this is widely used for the especial effects of the filmmaking, as well as various entertainment uses. For the scientific applications, it is regarded as one of useful image processing techniques for some animated or simulated effects. The morphing technique is widely used for 2D/3D graphic simulation with 2D/3D science data and surveying data. As for some the previous cases, Fell *et al.* (1998) used this for computer science education to be understood a design pattern. Bishop *et al.* (1999) applied this technique for the recovery process and animated visualization of long-term geological history. Further, Russ (2002) addressed the general use cases of warping and morphing algorithm. Ohira and Wada (2002) and Wimmers and Velden (2004) used this technique for cloud modeling and simulation in large range and scale variation. As well, Toll *et al.* (2005) reported NASA research activity for water cycle simulation using morphing. Scarmana and Fryer (2006) tested this methodology for enhancing a sequence of facial images under the condition with a few matched points.

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The idea of this work starts from simple motivation to investigate what information can be delivered in frame image which mean a sequence of images during the change from one image to the other by the morphing process with space-borne or airborne imageries. As well, how color blending effect in a resultant image by morphing process helps to interpret data sets is the second question. The main interest in this study is not development of new morphing technique, so that a simple feature-based method of transforming one image into another is to be implemented and applied to demonstrate example cases.

2. Briefing of the Applied Algorithm

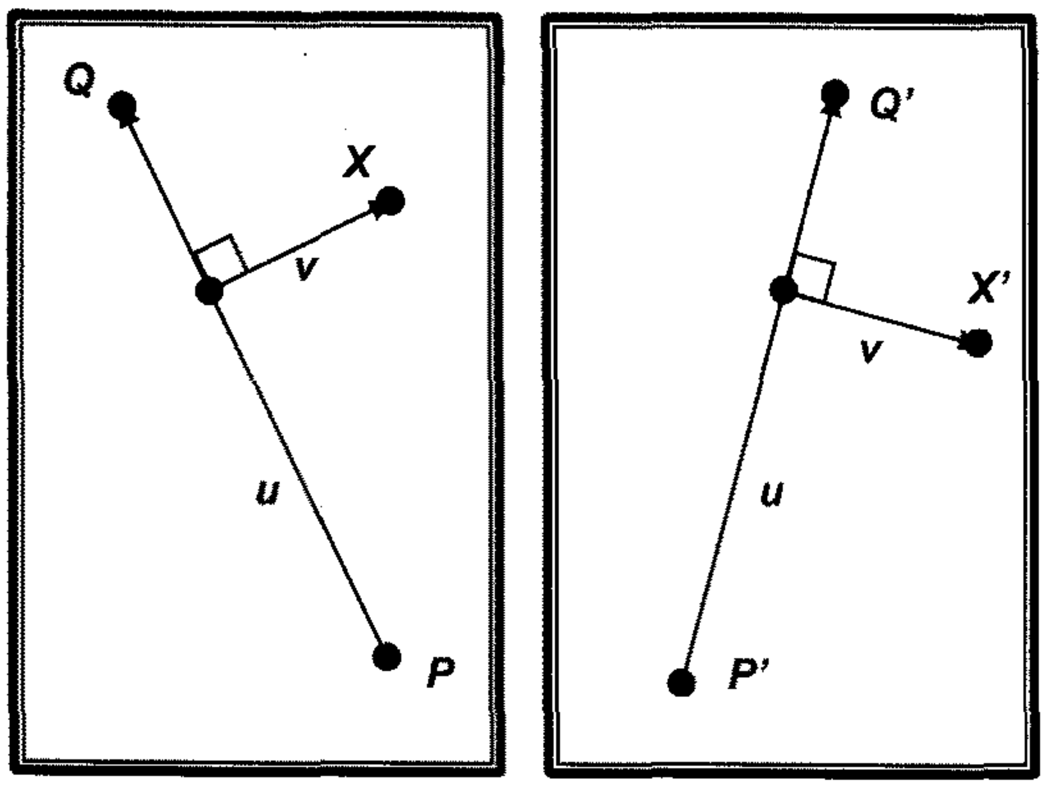
In general, the morphing is to generate a special effect which changes one image into another through a seamless transition, and it has been used in 2D motion pictures and 3D animations due to its visual impact, as well as various facial applications. Morphing techniques have been developed with mathematical basis from the 3D computer graphics, and they are provided in commercial 3D software: for instance, skin morph modifier and warp deformer modules in 3ds max® of Autodesk Inc.

This work is not focused on developing 2D/3D morphing technique, and well-known 2D image-based morphing scheme by Beier and Neely (1992) is adopted and implemented for the target datasets such as 2D airborne or space-borne imageries.

The morphing process is designed in cooperation with the warping process that distorts the first source image into the second. Reversely, its inverse process generates the second image distorted into the first. In this cross-dissolving, the first source image is gradually faded-out, while the second target image, destination image, starts out totally distorted and is faded-in toward the first. For proceeding the fade-in and fade-out between two images, the middle image of the sequence is the average of the first source image warped halfway toward the second one and the second image warped halfway back toward the first one. Thus, the morph process contains the warping process for two images so that the cross-dissolving between two images constructs the resulting image. The Beier and Neely algorithm is based on the warping and the interpolating for a resultant image, by using feature-matching with a simple geometry, shown in Fig. 1.

The feature line, line segment composed of control points, in the source image is defined its endpoint P' and Q'. The corresponding feature line in the destination image to be morphed has endpoints P and Q. These two line segments define an inverse mapping from the destination image pixel coordinate X to the source image pixel coordinate X'. Transformation with multiple-pairs of lines can be extended with single-pair, and an interpolated value for each pixel X in the destination image, a weighted combination of the transformations performed by each line, can be obtained as below.

$D_{SUM} = (0,0)$
  For each line defined by P_i and Q_i
    calculate u and v based on P_i and Q_i
    calculate X'_i
    calculate displacement $D_i = X_i' - X_i$ for this line
    $dist$ = shortest distance from X to line defined by P_i and Q_i
    $weight_i = (\text{length}^p / (a + dist))^b$
    $D_{SUM} += D_{SUM} * weight_i D_i$
  end
  $X' = (X + D_{SUM}) / \text{sum}(weight_i)$
Round elements of X' to nearest integers Z'
Destination Image(X) = Source Image(Z')
end



Destination image **Source Image**

Fig. 1. Single line pair geometry for the Beier and Neely algorithm.

As for the weighting parameter (*weight*), length and *dist* are the length of the line and the distance from the pixel to the line, respectively. By increasing of parameter a, he warp is made more smoother. The variable b determines how fast the effect of distance falls off. Parameter p relates the effect of the length of the line to the weight. This method goes through each pixel in the destination image and samples an appropriate source image pixel. Thus, all destination image pixels are mapped to some source image pixel. The weight used depends on the distance of the point under consideration from the line. The weight can also depend on the length of the line. This transformation, based on multiple lines, can be used effectively for morphing. The algorithm transforms each pixel coordinate by a rotation, translation, and/or a scale, thereby transforming the whole image. All of the pixels along the line in the source image are copied on top of the line in the destination image. In this case, one line in the source image is mapped to a corresponding line in the destination image. The other parts of the image are moved appropriately to maintain their relative position from specified line.

Fig. 2 is an example by a commercial tool named FANTAMORPH by Abrosoft. Two data images are used: one source and another destination image. By

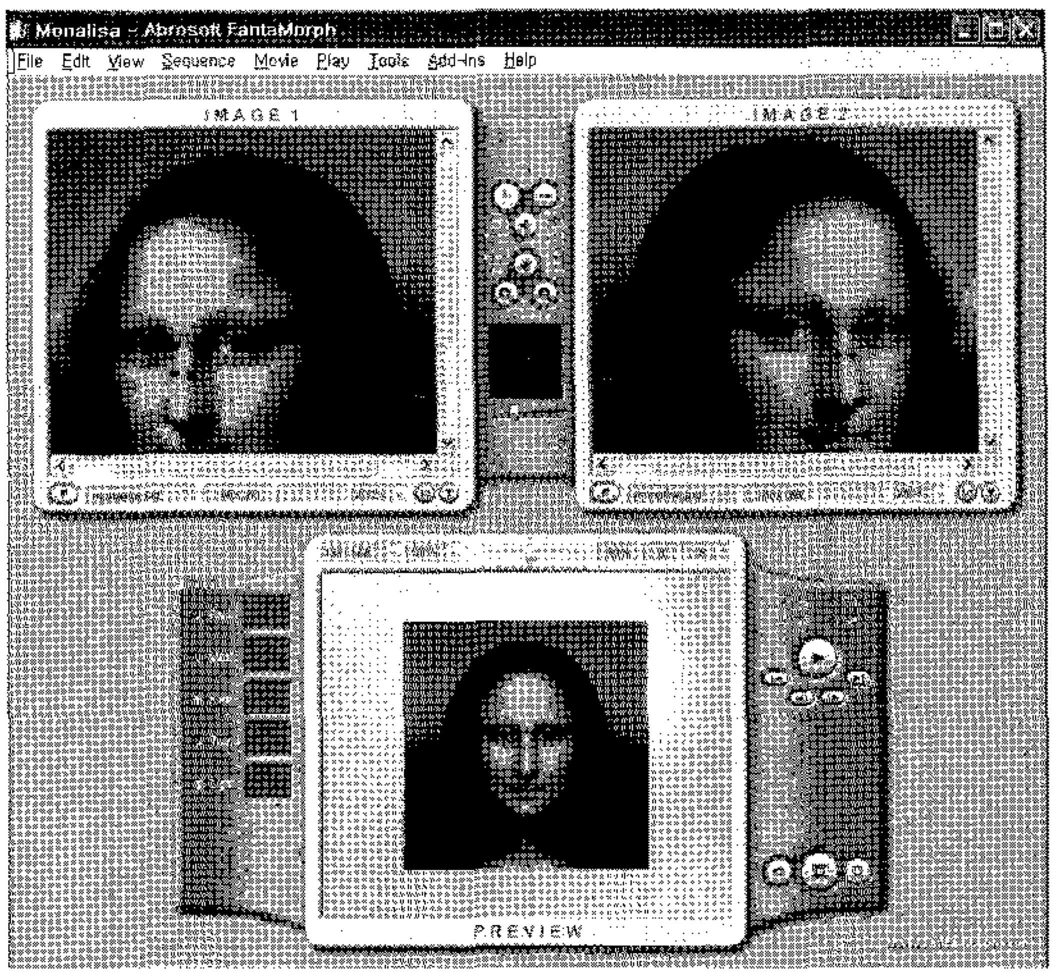


Fig. 2. General application of morphing technique using FANTAMORPH tool: An example on special effect. FANTAMORPH is a trademark of Abrosoft Co.

morphing process with systematic control points, an average image warped halfway from both input images, the middle image of the sequence, is constructed. This is a demonstration for currently general uses of image-based morphing technique.

3. Implementation

The motivation of this work is to investigate what information in intermediate sequence of images during the change from one geo-based image to the other image by obtained different sensors or sources might be contained or how much deliverable as for that information.

Fig. 3 represents the user interface and the main features provided in this implementation, using MFC-based VC++ coding, to perform this approach scheme and shows a simple example of image warping by feature matching scheme. In this interface, two main functions of warping and morphing are separately provided. As for the grouped or the preset control points' manipulation, some executions are available: save, load, and reset. For

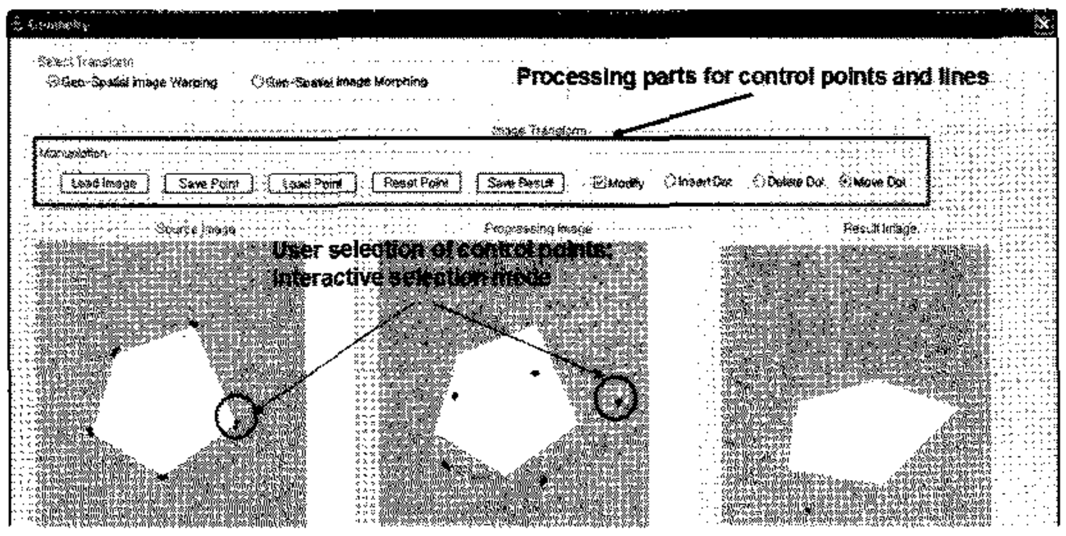


Fig. 3. Implementation results: User interfaces and control point selection.

each control point, some functions such as insert, delete, move, and modify are provided. As well, user can use interactive selection mode on loaded images. Once two images are optionally warped, these can be applied to morph by feature matching by means of the selection of control points in the first image and its corresponding points in the second one. By morphing, two products are obtained: a resultant image and frame images representing image transition pattern for the morphing progress.

4. Applied Cases

The scheme under this approach is presented in Fig. 4. Two images are used: source 1 as the first image and source 2 as the second image or destination image. Each image can be applied to warp itself for reducing mismatch error in a resultant image. In this warping, auxiliary information such as GCP (Ground control point) also can be used. But it is notice that the purpose of this work does not primarily orient to obtain some geo-rectified images so that the computation for accuracy assessment such as error matrix or kappa statistic is not included in this scheme, although this warping can be regarded as geometric correction or geo-rectification process with the basis of image-to-map or image-to-image.

Case I is to process the forward or the reverse mapping in the Beier and Neely algorithm. In the case of the reverse process, source image is returned to original one; in the middle of the morphing process, several frame images can be obtained and archived in graphic file formats. While, in applying for Case II, the final image shows the average image which is composed of blended color. This effect is similar to alpha blending effect to represent a transparency between two image sets by the pixel pipeline operation

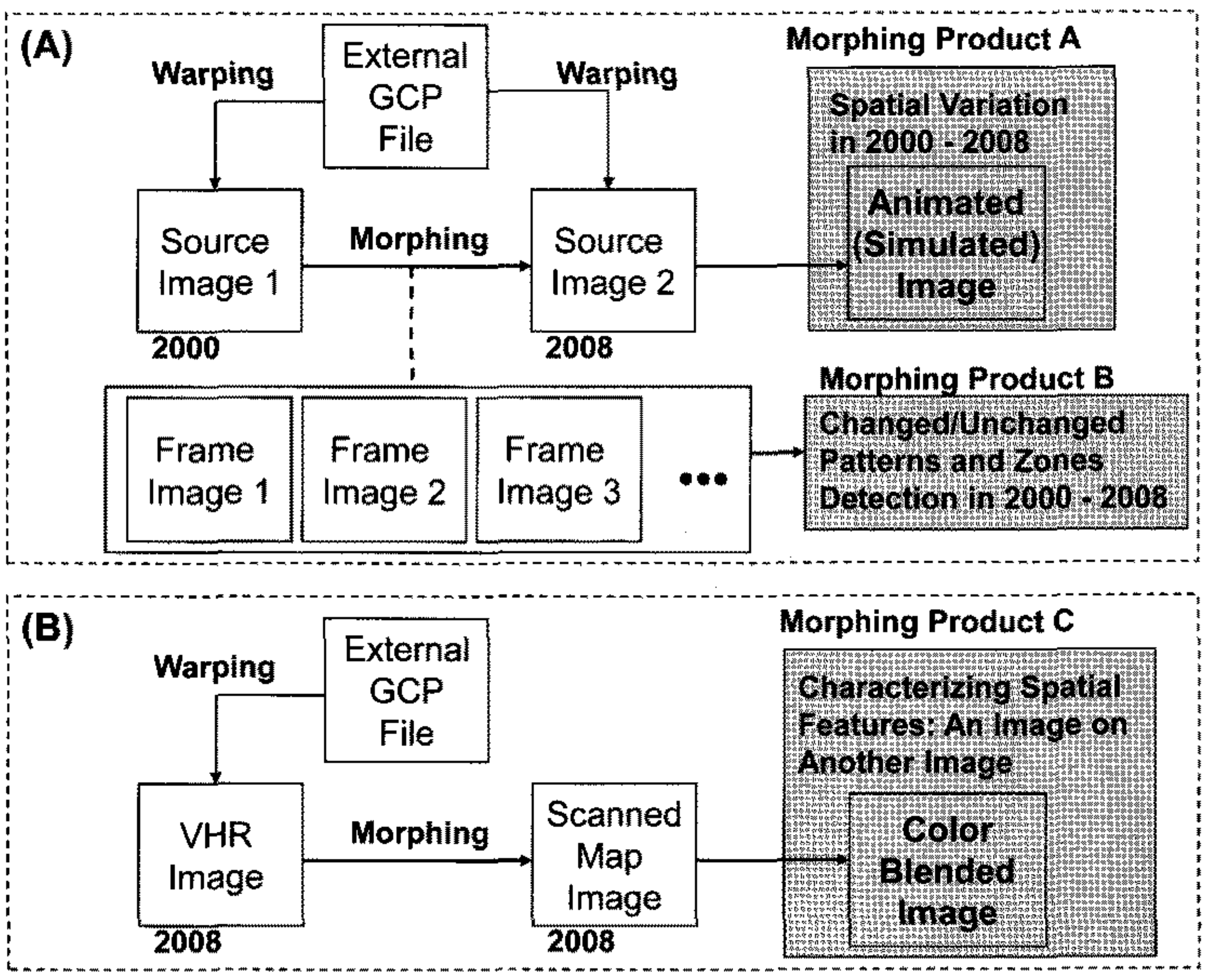


Fig. 4. Some cases of the morphing applications using geo-spatial data sets.

in general computer graphics. This morphing process also left frame images just like Type A mode.

Using an implemented prototype, two examples are presented in Fig. 5 and Fig. 6. Actually, these examples are just for demonstration, so that these are processed with test data. Fig. 5 shows one kind of the morphing examples, referred to Fig. 4(A). The source image numbered and the destination image are a panchromatic image and a high-resolution color composite image acquired at different time, respectively. In this mode, the animated effect by a sequence of intermediate frames is generated. The frame images are also archived in the graphic file format.

Fig. 6 shows another simple example of the morphing applications. It corresponds to Fig. 4(B). Some different types of image set are tested: an airborne image and a scanned map. Final image is a color-blended image, revealing some discernable

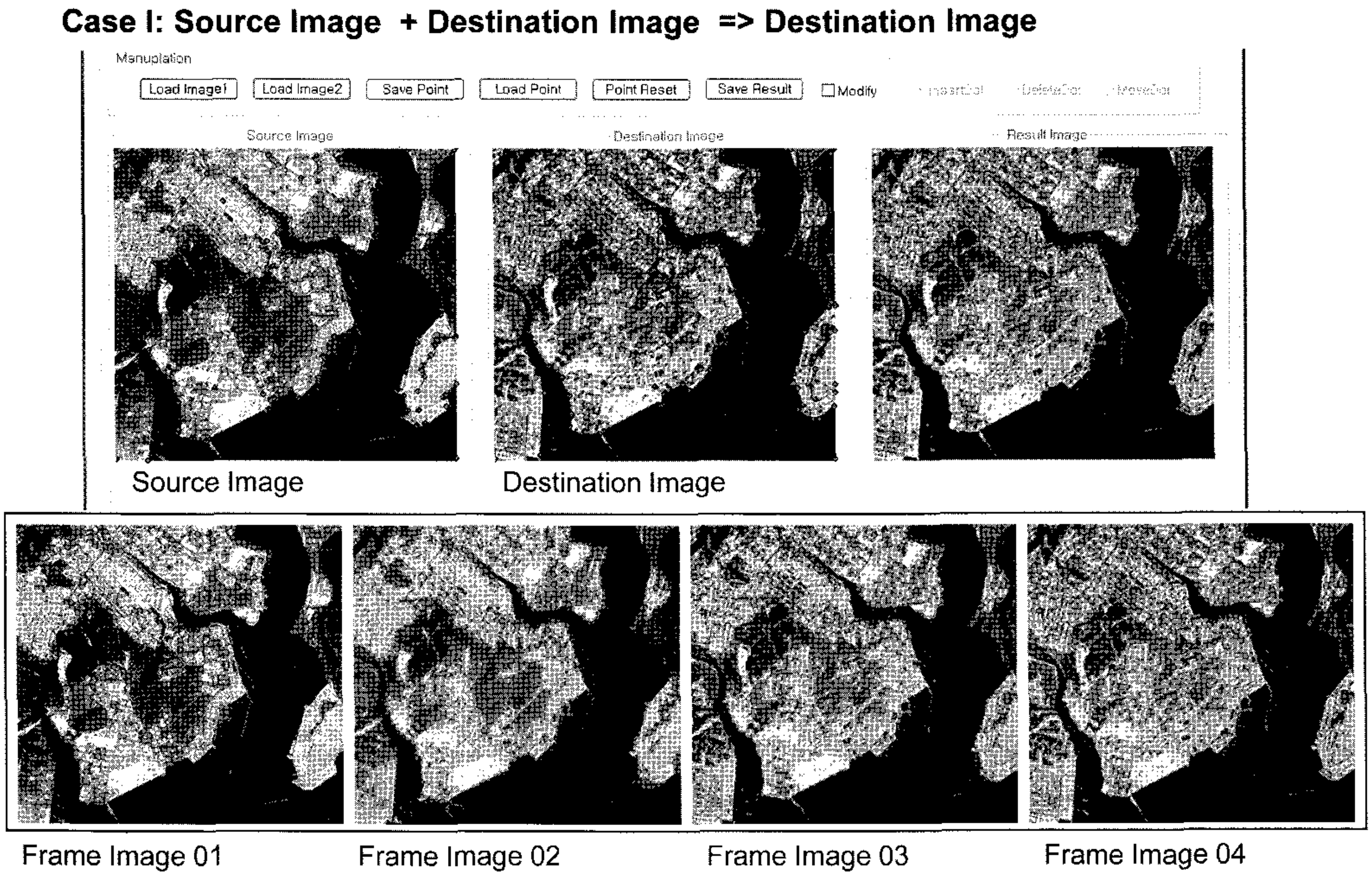


Fig. 5. Morphing application: A case of Figure 4(A).

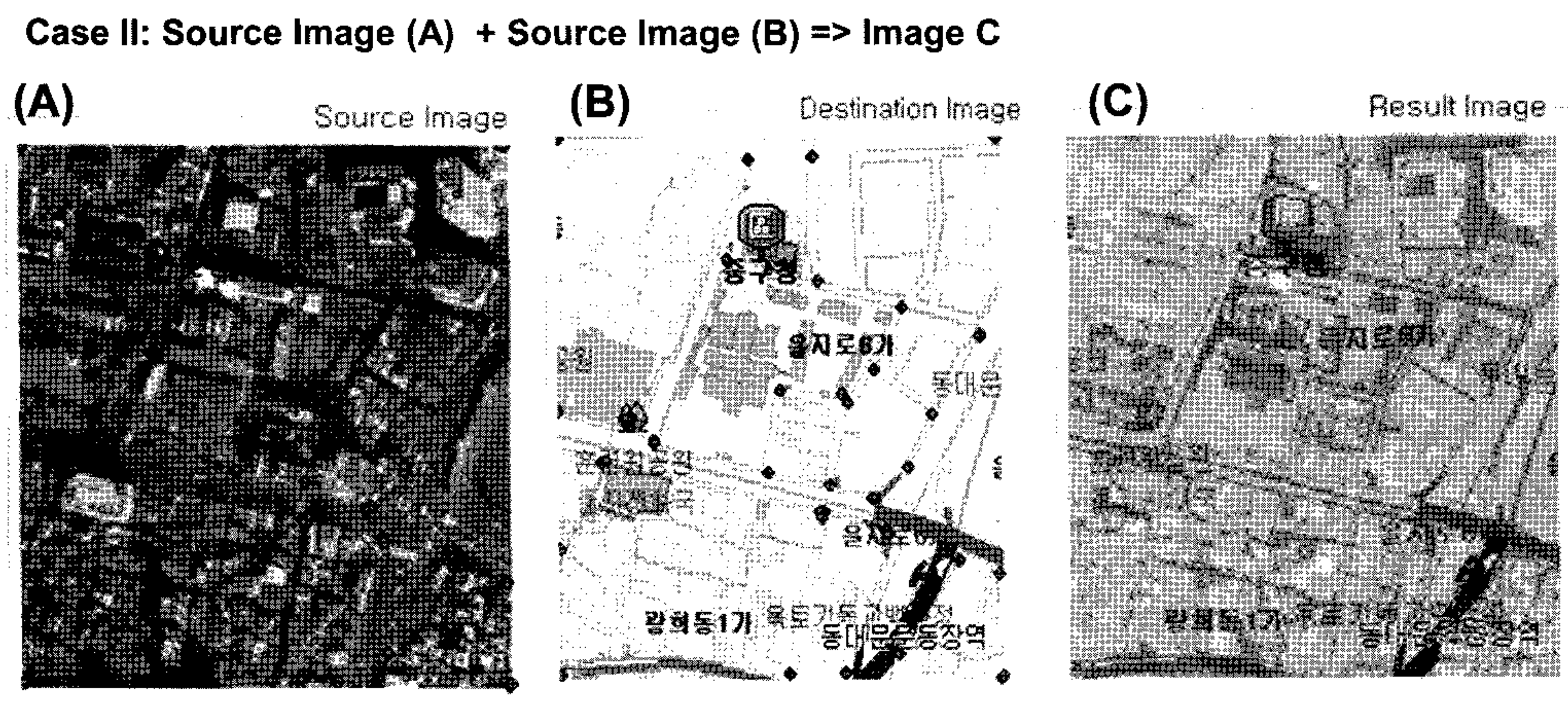


Fig. 6. Morphing application: A case of Figure 4(B).

features in both images. This approach can be utilized to qualitatively interpret and to construct an integrated image from heterogeneous typed image sets.

5. Concluding Remarks

In these days, general uses of airborne or space-borne imagery are one of emerging trends in remote sensing. Processing schemes or techniques for the especial effects techniques are necessary for value-added contents on those. As for these trends, the Beier and Neely morphing algorithm is implemented and tentatively demonstrated in this study. Image-based morphing can be used for multi purposes: image simulation between two images, change detection problem and constructing color-blending image between source image and destination image. Among them, change detection problem using the morphing process is now under practical considerations. By inspection of many frame images for a given period, unchanged patterns or zones show constant, but changed ones are gradually transited. Thus this transition zone may be extractable or interpretable to changed pattern with animation effect. Conclusively, these approaches show the main advantages that the warping helps for geo-rectification, that different typed sensor images are used without limitations, and that several resultant images such as the animated scene and the color-blending image can be obtained in a simple morphing process with a sequence of frame images, although this work is on the prototyped stage.

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