A Novel Graduation Algorithm in Image Mosaic

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Abstract

The Bernstein polynomial is one of the classic algorithms of panoramic images mosaic for shading into process applying in Virtual Reality modeling. Nevertheless, it is proven that the algorithm has its own limitation and weakness in applications. This paper was given the improved algorithm using Sinusoidal function for image mosaic. In order to put the new algorithm into image processing software as a flexible and general tool, it was further developed an extension for graduation image fusion and multi-images mosaic.
Keywords：image mosaic，Sine graduation algorithm，image fusion

1. Introduction

Image Mosaic is a useful and important function in an image processing software. It is mainly used to build panoramic images in Virtual Reality and scene images in Remote Sensing. There are at least two important steps for image mosaic: image match（Registration）and image seamless mosaic. The former one is used to decide the image overlapping positions; and the later one is executed the graduation mosaics. Bernstein polynomials algorithm was compared as a less calculation and a grey or color graduation purpose, but it is only supported a 1D graduation that is caused a serious gap between the images in another direction. In order to solve the issues above, not only the algorithm was improved dealing with 2D graduation but also a gradual merging algorithm was advanced and given the results in remote sensing, virtual reality and art image fusion.

2. Classic Bernstien polynomials algorithm

Rather than simply calculate an average value of the pixel in the wrap area, Bernstein polynomials algorithm uses a gradual coefficient to get the value. Bernstein polynomials as follows:

$$F' = \sum_{i=0}^{n-1} \begin{bmatrix} n-1 \\ i \end{bmatrix} t^i (1-t)^{n-1-i} F_i \qquad (1)$$

If Image3 will be the result and image1、image2 are overlapping parts of two images, the equation as follows:

Image3=（1-p）*Image1+p*Image2 （2）

Where p is the gradual coefficient from 1 to 0. Usually, a linear gradual coefficient is set up and written as p=*i*/Width, where *i* is the column in the wrap area, Width is the width of the wrap area.

3. Sinusoidal function graduation technique

When the brightness of images is existed a great difference, an obvious sewing line will be appeared on the edge of the wrap area which is caused of two discontinued points at x1 and x2 on curve obviously. In order to search a suitable curve, it should meet a condition like keep continuous on the close interval [x1, x2]：

1） $f'_+(x1) = 0$, $f'_-(x2) = 0$;

2) The function f(x) should be continuous on the open interval (x1, x2), then given the sinusoidal function:

$$p=A\sin(w*x+\varphi)+T \qquad (3)$$

It is shown an improved and smoothed corner points in Figure 1 and the equation should be:

$$p'=0.5\sin(\pi x'-0.5\pi)+0.5 \qquad (4)$$

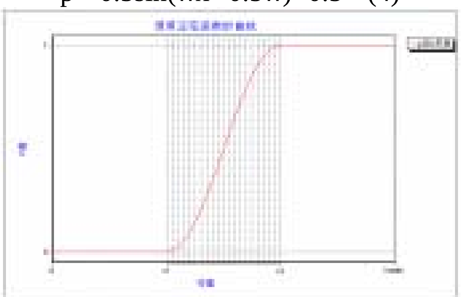


Figure 1 sinusoidal function gradual coefficient curve

4. 2 D graduation technique

For the sake of 2D Bernstein polynomials algorithm, it is supposed H represent a horizontal direction as G and vertical direction as F, and the equation can be written as:

$$H = pw*G+(1-pw)*F \qquad (6)$$

Where *pw* is the percentage of a weight, *pi* is a weight of rows and *pj* is a weight of columns, such:

$$Pw = pi/(pi+pj) \qquad (7)$$

In this case, the sinusoidal function equation as follows:

$$pi=0.5*\sin(2\pi i-0.5\pi)+0.5\ ;\ pj=0.5*\sin(2\pi j-0.5\pi)+0.5 \quad (8)$$

The sine function shows a better result (Figure 2) and the technique has proven to work remarkably well in our experiment (figure 5) riding of all the critical points.

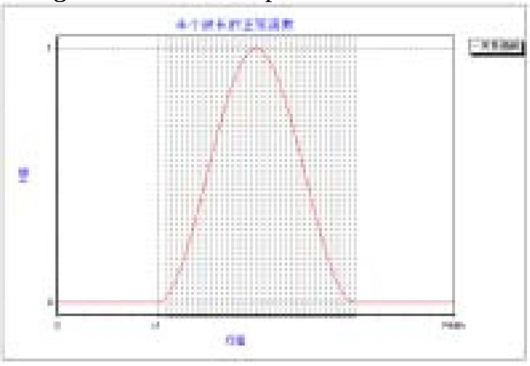


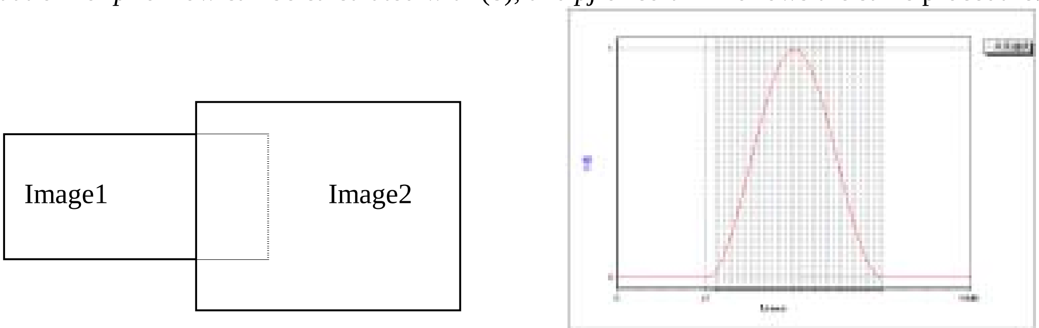
Figure 2 2D graduation sinusoidal function analytic curve

5. Two techniques for extending the algorithm

During a software developing procedure of a hyperspectral image processing system, this algorithm was found its practical values but still needed an extended support for flexible use in various applications.

5.1 Inclusive mosaic technique

Although the improved algorithm provides 2D process, it is impossible to deal with the full-line or full-column wrap area (Figure 3a). When the pixel is scanned from up to down, the wrap area should be changed from image2 to image1 and then from image1 to image2. Figure 3b was described the relation curve. In this case, the equation for *pi* or row can be calculated with (8); and *pj* or column follows the same procedure.



(a) The example of full-column wrap area **(b) The relation curve about pi and line**

Figure 3 Full-column wrap area and its relation curve

In order to integrate the algorithm into the system, the equation (4) was replaced p' with equation (9).

$$p = 0.5*\sin(a\pi j-0.5\pi) + 0.5 \quad (9)$$

where parameter *a* is in two cases:

$$\begin{cases} 1. \text{ Full line or Full column} \\ 2. \text{ Otherwise} \end{cases} \quad (10)$$

This algorithm is not only used in image mosaic, but also in Art Image Fusion. Usually, image fusion presents the characteristic of all image layers simultaneously in the wrap area.

5.2 Multiple images mosaic technique

When the images are more than two overlapping instance, the wrap areas of images are not all regular rectangles shown in figure 4, the algorithm is no longer suitable to them. Here we have to separate the overlap wrap area into several regular parts (3 parts) shown in figure 4b and to use the algorithm in each part. But it must follow the regulars below:

1) The number of separated parts should be as small as possible and the area of them vice versa.
2) The gradual property may be changed such as: the area is become an IncFlds if the wrap area is separated with crossing relation.

(a) The overlap wrap area **(b) Seperated wrap areas**

Figure 4 Multiple Images Mosaic

In the first case, a Greed-Method was used to get the overlapping areas first and to calculate the number of the edges from them. If it is 2, the first wrap area is split otherwise the second one is split. And then separate another wrap area follows the same. In the second case, the graduation features need to be judged when the wrap area is split.

6. Results

The following are the results of 2D graduation and multiply image mosaic algorithm. Figure 5 is for 2D graduation algorithm. It shows that the algorithm can process 2D graduation well.

(a) Original algorithm **(b) 2D graduation algorithm**

Figure 5 2D graduation algorithm

And figure 6 was shown the result of Remote Sensing image mosaic using integrated algorithm.

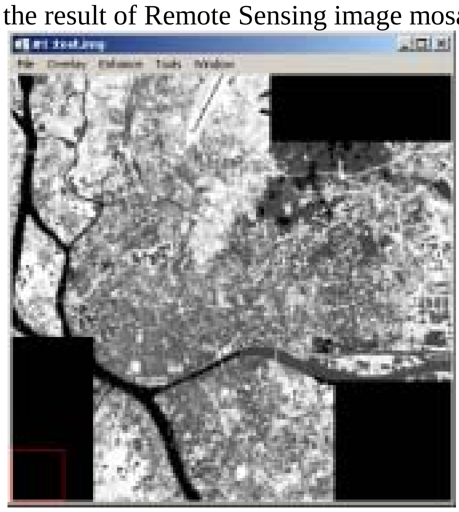


Figure 6 Multiple images mosaic

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