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Multiresolution Image Mosaicing Applications

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Abstract— Image mosaicing is an effective technique for combination of two or more images. The construction of mosaic images and the use of such images on several computer vision/graphics applications have been active areas of research in recent years. The most common mosaicing applications include constructing high resolution images that cover an unlimited field of view using inexpensive equipment, creating immersive environments for effective information exchange through the internet. Another attractive application of image mosaicing is in making the advertisement more interesting and effective. Our work focuses effective advertising using image mosaicing. In this work, we have used wavelet transform for multiresolution image mosaicing. The mosaicing of images is carried out in two main stages, in first stage the images to be mosaic are registered first & in second stage we perform blending of intensity of those images. Here a special approach is given to polymasking to form different mask according to the need of various applications.

Keywords— Image mosaicing, Gaussian method, laplacian method, multiresolution mosaicing, wavelet transform.

I. Introduction

Image mosaicing is an effective technique for combination of two or more images. In this technique, we have used wavelet transform, Laplacian pyramid, Gaussian pyramid for multiresolution representation, which is widely used in most of the application like signal analysis, image processing, image coding, computer vision etc. Multiresolution representation technique is an effective method for analyzing information contents of signals, as it processes the signals individually at finer levels, to give more accurate results that contains much less distortion.

An image mosaicing requires two stages for its implementation. In first stage two images to-be combined are identified and registered. In second stage the corresponding pixels of the images are blended. It is too difficult to form an ideal mosaic image without any obstructive boundary, but an image mosaic processing technique can be applied greatly to reduce this difficulty. When two or more images are overlapped to form a single mixed ideal image there may be chances of edging takes place. To mosaic an image is to combine overlapped images so that the mixed image contains no obstructive boundaries in the transition region while care is taken to preserve the general appearance of the original images. Blending technique overcomes the edges; it combines images such that no obstructive boundary exists around overlapped regions. It forms a new mosaic image without loss of original appearance of images.

Our previous work on image mosaicing was focused on multiresolution image mosaicing. In the proposed technique, we extend the use of multiresolution image mosaicing for feature mosaicing; here we have performed mosaicing on two different faces. With the help of such feature mosaicing we can form a new face with new features by using two different faces, but without loss of original appearance of images.

In this method, the to-be-combined images are first projected into wavelet subspaces. The images projected into the same wavelet space are then blended. Here blending function is derived from an energy minimization model which balances the smoothness around the overlapped region and the fidelity of the blended image to the original images [1]. Image mosaic combines *two* or more images into a new one with an invisible seam, and with as little distortion of each signal as possible. Multiresolution representation is an effective method for analysing the information content of signals and it also fits a wide spectrum of visual signal processing and visual communication application [2]. Of previous works of mosaicing, the method proposed by Burt and Adelson [3] is most popular method which uses spline functions for blending sub-band coefficients based on multiresolution pyramidal representation. The Multi-resolution process is also carried out with the help of Laplacian pyramid using Gaussian pyramid [4] [5].

Wavelet transform is one kind of multiresolution representations, and has found a wide variety of application in many aspects, including signal analysis, image coding, image processing, computer vision and etc. Due to its characteristic of multiresolution signal decomposition, wavelet transform is used in this paper to do the image mosaic by choosing the width of mosaic transition. The work of this paper is focused on designing a model with variable mask instead of using a predefined mask (fixed mask) for various features of an images or combination of images. Here we can select the mask according to our choice by selecting a proper region with the help of pointer. This paper is organized as follows: In section 1, we discuss the multiresolution analysis with wavelet transform, section 2, highlights the use of wavelet transform for image mosaicing as well as blending technique used for the mosaicing. In section 3, we present multiresolution techniques to get resultant image with high resolution. In section 4 we described implementation algorithm for mosaicing purpose. In section 5 we present experimental results obtained with the proposed approach. Finally, section 6 summarizes the practical application of image mosaicing and discusses the future work directions.

II. Multiresolution Analysis With Wavelet Transform

A 2-D biorthogonal multiresolution analysis can be obtained by means of a tensor product, from two one-dimensional (1-D) biorthogonal multiresolution analysis, which obtains the scaling functions as given below: [1]

$$\Phi_{j;k,m}(x,y) \text{ and } \tilde{\Phi}_{j;k,m}(x,y)$$

And the wavelet function

$$\Psi^{p}_{j;k,m}(x,y) \text{ and } \tilde{\Psi}^{p}_{j;k,m}(x,y) \text{ with } p \in \{H,V,D\},$$

respectively, where $\Phi_{j;k,m}(x) = 2^{-j}\phi(2^{-j}x-k)\phi(2^{-j}y-m)$

and

$$\Psi^{H}_{j;k,m}(x) = 2^{-j}\phi(2^{-j}x-k)\psi(2^{-j}y-m) \quad (1)$$

$$\Psi^{V}_{j;k,m}(x) = 2^{-j}\psi(2^{-j}x-k)\phi(2^{-j}y-m) \quad (2)$$

$$\Psi^{D}_{j;k,m}(x) = 2^{-j}\psi(2^{-j}x-k)\psi(2^{-j}y-m) \quad (3)$$

Based on wavelet theory, an image $f(x,y)$ in the n^{th} multiresolution analysis space can be projected into subspace images. The original image can then be reconstructed by summing all of the subspace images, i.e.

$$f(x,y) = \sum_{j=0}^{N} f_j(x,y) \quad (4)$$

The above equation indicates that the subspace image fj(x,y) is obtained by blending the left part of $l_j(x,y)$ of and the right part of $r_j(x,y)$ from seam line L.

$\mathcal{M}_{\epsilon_j}$ indicates the blending operator. The parameter ϵ_j indicates that the overlapped region of $l_j(x,y)$ *and* $r_j(x,y)$ is within a distance of ϵ_j from the seam line L . Note that, instead of being blended in sub-band coefficients, images are combined in their wavelet subspaces. As a result, $f(x, y)$ can be obtained by directly summing the blended subspace image $f_j(x, y)$ by (4) without being affected by the synthesis filters.

The blending operator $\mathcal{M}_{\epsilon_j}$ can be expressed as the following polynomial weighting formula to merge the corresponding points in each image: [1]

$$\begin{aligned}
&\mathcal{M}_{\epsilon_j}(l_j(x,y), r_j(x,y)) \\
&= c_{j,0}(x,y) + c_{j,11}(x,y)l_j(x,y) + c_{j,12}(x,y)r_j(x,y) \\
&\quad + c_{j,21}(x,y)l_j^2(x,y) + c_{j,22}(x,y)r_j^2(x,y) \\
&\quad + c_{j,23}(x,y)l_j(x,y)r_j(x,y) + HigherOrderTerms(x,y)
\end{aligned}$$

(5)

Where $C_{(.)}(x, y)$ is a weighting coefficient function for each term. In special cases, when *(x, y) and* $r_j(x,y)$ and are identical, i.e.

$$l_j(x,y) = r_j(x,y) = \check{f}_j(x,y),$$

Then the resultant subspace image $F_j(x, y)$ should be identical to the input subspace image $\tilde{f}_j(x,y)$ after applying to input subspace images. That is

$$\begin{aligned}
\check{f}_j(x,y) = &c_{j,0}(x,y) + c_{j,11}(x,y)\check{f}_j(x,y) \\
&+ c_{j,12}(x,y)\check{f}_j(x,y) + c_{j,21}(x,y)\check{f}_j^{\,2}(x,y) \\
&+ c_{j,22}(x,y)\check{f}_j^{\,2}(x,y) + c_{j,23}(x,y)\check{f}_j^{\,2}(x,y) \\
&+ \text{Higher Order Terms}(x,y)
\end{aligned} \quad (6)$$

Because (6) must hold for any arbitrary input image $\check{f}_j(x,y)$

it is necessary that,

$$c_{j,0}(x,y) = 0 \quad c_{j,11}(x,y) + c_{j,12}(x,y) = 1$$
$$c_{j,21}(x,y) = c_{j,22}(x,y) = c_{j,23}(x,y) = 0$$
$$\text{Higher Order Terms}(x,y) = 0$$

(7)

Now, letting , $w_j(x,y) = c_{j,11}(x,y)$ operator $\mathcal{M}_{\epsilon_j}$ becomes

$$\mathcal{M}_{\epsilon_j}\,(l_j(x,y), r_j(x,y)) = w_j(x,y)l_j(x,y) + (1 - w_j(x,y))r_j(x,y)$$

(8)

In the following discussion, we derive $\mathcal{M}_{\epsilon_j}$ an optimal from an energy minimization model in each wavelet subspace 2^j.

The final mosaic image $f(x,y)$ is obtained from

$$f(x,y) = \sum_{j=0}^{N} f_j(x,y) = \sum_{j=0}^{N} \mathcal{M}_{\epsilon_j}(l_j(x,y), r_j(x,y))$$

(9)

III. MULTIRESOLUTION TECHNIQUES

Following are the two important pyramid structures. In this section we present a highly efficient "pyramid" algorithm for performing the required filtering operations and also we show that the pyramid structure is ideally suited for performing the splining steps as well. Hierarchical representation of an image is shown in Fig. 3.1.

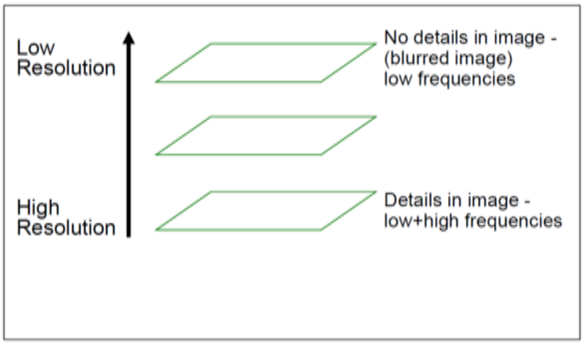

Fig. 3.1 Hierarchical representation of an image

In case of image mosaicing generally two types of pyramidal operations are used, *i.e.* Laplacian pyramid and Gaussian pyramid. In this work, we are applying Laplacian function on two input images and Gaussian function on masked image for finer resolution. In case of pyramidal blending we can mosaic different part of various images *i.e.* we can combine right part of one image to the left part of another image. Due to this pyramidal blending, the obstructive boundaries get converted into smooth transition region. The figure 3.2 shows pyramidal blending model. In this blending left part of one image is get blend with the right part of another image. In case of blending, the pixel values of images are mixed in each other in such a way that, the image view should be clear so that the boundary should be invisible. In pyramidal blending mixing of images are done with new appearance but without loss of original image appearance, here left part of image is get blend with the right part of image.

Blending corresponds to the weighting average of those pixels which are going to combine to form uniform region. This blending disappears the edging problem.

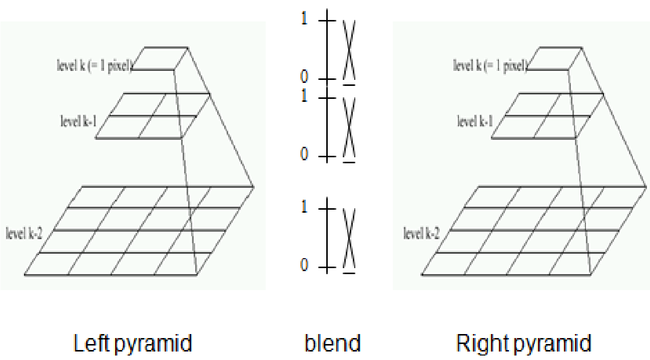

Figure 4.4: Pyramidal blending model

IV. Implementation Algorithm

Following figure shows implementation algorithm that to be used for image mosaicing purpose.

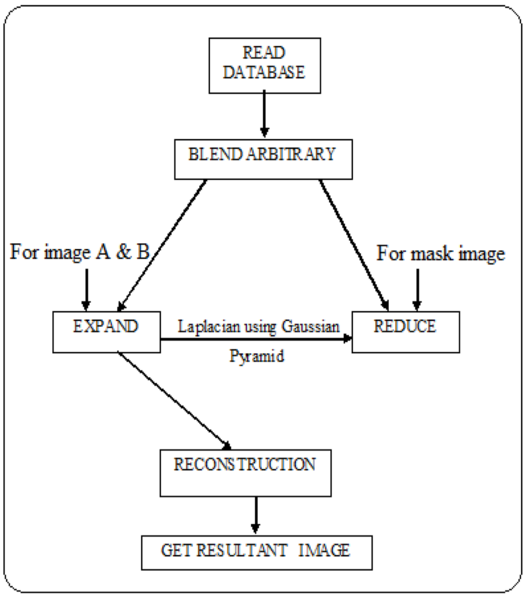

Figure 4.1: Flowchart for Implementation Algorithm

4.1 Read Database

1. Read the three images i.e. A, B, Mask.
2. Convert color images to gray.
3. Call the Blend arbitrary function as these three images as argument along with number of decomposition levels.

4.2 Blend arbitrary

1. Read number of rows and columns of input image matrix.
2. Call Laplacian pyramid function for A and B images with number of levels.
3. Call Gaussian pyramid function for Mask image with number of levels.
   Here we have used polymasking technique.
4. Also get compliment of mask with region of interest.
5. By using Mask as weighted function add two pyramids to get resultant pyramid for each level.
6. Reconstruct pyramid by using reconstruct function.

4.3 Laplacian pyramid

1. Read number of rows and columns of input image matrix.
2. Call Laplacian pyramid function for input image with number of levels.
3. Get particular level laplacian matrix by taking subtraction of that level Gaussian matrix and expanded version of previous Gaussian matrix.
4. Return the Laplacian pyramid

4.4 Gaussian pyramid

1. Read number of rows and columns of input image matrix.
2. Calls the Gaussian function which convolve the input matrix with LPF matrix structure & subsample it by 2.
3. Return the Gaussian pyramid which is formed.

4.5 Reduce

1. Design triangular low pass filter such that the total is one. Get the two dimensional structure of the filter by convolution of same matrix with its compliment.
2. Get the expanded version of by image by adding 2 extra lines on each side of matrix.
3. Again LPF it with same triangular filters.
4. Now get original matrix size back and return it.

4.6 Expand

1. Read number of rows and columns of input image matrix.
2. Interpolate each row and column by adding extra zeros.
3. To get smooth version of whole image it is convolved with triangular filter.

4. To boost up the values multiply each element by four.
5. Return the resultant matrix.

4.7 Reconstruct

1. Read number of rows, columns and level of input image pyramid.
2. For getting resultant image add n^{th} level matrix to expanded version of its previous level matrix.
3. Go up to 1^{st} level in same way to get resultant image.
4. At last we will get the mosaic image with smooth transition.

V. Results

Here we have taken different results of image mosaicing, which we can use for advertisement purpose or wherever we want to combine multiple images, also to give movie special effects.
The following databases shows examples of image mosaicing like feature mosaicing, to-be combined mosaicing which we can use for the purpose of advertisement.

Figure 5.1: Feature Mosaicing

Similarly, we have taken number of results for image mosaicing as shown in following figures.
In fig. 5.2 we have taken two separate images out of which one consists of a 'Metro train' and other consist of a 'Sea' after mosaicing it is looking like that, the metro train is running through the sea water and we know that train can't run without a particular track. So by using such mosaicing we can give movies special effects and this can be widely used in advertisement.

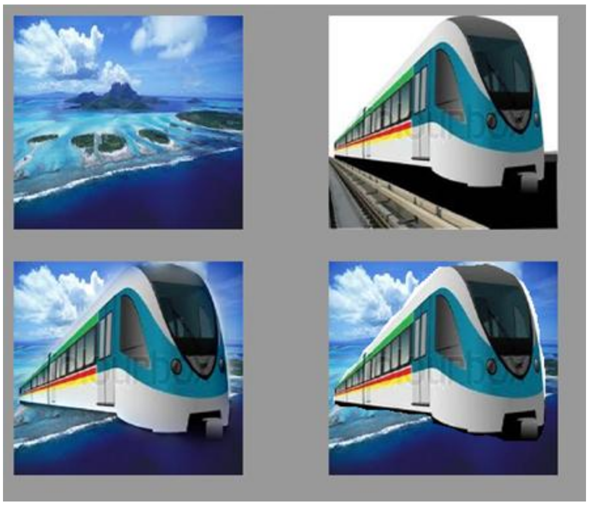

Figure 5.2 Image mosaicing for advertisement purpose
(Movie special effects)

We can use results of figure 5.2 for animation purpose i.e. we can change background of this train, here sky with sea is there we can show mountain, island, trees, building etc. for a background effects.

Figure 5.3 shows to-be combined image mosaicing, this mosaicing can be used to make advertisement more interesting. Here images of two girls are used, instead of using two person images we may use images of two animals too. If we want a person with animal for some effects we may use a person with animal.

In certain cases, it is too difficult to be with a danger animal like tiger, dinosaurs, anaconda etc. so image mosaicing effects provide the facility to be there with dangerous animal too.

Like this we can use the image mosaicing for numerous applications.

Figure 5.3 To-be combined images

VI. Conclusion

Subjective comparison has shown that the image quality achieved by the proposed technique is better than any other method. In our work we have proposed three main tools for image mosaicing; those are Laplacian pyramid, Gaussian pyramid and Wavelet transform. Smooth transitions of images are occurred without losing original appearances of images. Special mosaic effects can be achieved by combining components with specific frequency. We can select different input images for image mosaicing along with multiple mashing. To simplify shape mosaic, we have used dynamic masking technique instead of using fixed binary mask. Here, there is no edging problem in feature mosaicing as well as in to-be combined image mosaicing. One of the major limitations of this method is that we cannot take more than two input images at a time, but we can select multiple images with the combination of two images, then we can form a composite image. It is expected in future that the technique of image mosaicing can be applied to video mosaicing as well as 3D image mosaicing.

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