A NOVEL STILL IMAGE MOSAIC ALGORITHM CONSTRUCTION USING FEATURE BASED METHOD

DEEPAK KUMAR JAIN[1], GAURAV SAXENA[2] & VINEET KU. SINGH[3]

[1,2&3]Jaypee University of Engineering and Technology, Guna (M.P.), India
E-mail : Deepak.jain.juet@gmail.com, gaurav.saxena@juet.ac.in

Abstract- An image mosaic is a method of assembling multiple overlapping images of same scene into a larger one. The output of image mosaic will be the union of two input images. In this paper we have to use three step automatic image mosaic method. The first step is taking two input images and finding out the corners in both the images, second step is finding its matched corner and third step is its blending and we get final output mosaic. The experimental results show the proposed algorithm produces an improvement in mosaic accuracy, efficiency and robustness.

Keywords- *Mosaicing, Registration, Stitching, Warping, Blending.*

I. INTRODUCTION

Image mosaicing is a process of assembling images of same scene into a large image. The output of image mosaicing operation will be the union of two input images. An Image mosaic is a synthetic composition generated from a sequence of images and it can be obtained by understanding geometric relationships between images. The geometric relations are the coordinate system that relate the different image coordinate systems. By applying the appropriate transformations via a warping operation and merging the overlapping regions of warped images, it is possible to construct a single image indistinguishable from a single large image of the same object, covering the entire visible area of the scene. This merged single image is the motivation for the term mosaic.

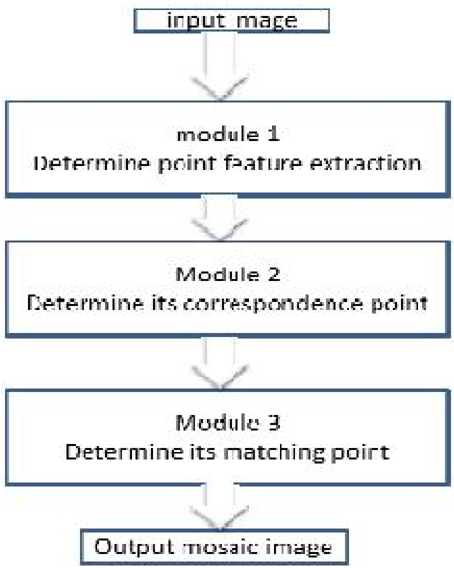
Various steps in mosaicing are feature extraction and registration, stitching and blending. Image registration refers to the geometric alignment of a set of images. The set may consist of two or more digital images taken of a single scene at different times, from different sensors, or from different viewpoints. The goal of registration is to establish geometric correspondence between the images so that they may be transformed, compared, and analyzed in a common reference frame. This is of practical importance in many fields, including sensing, medical imaging, and computer vision.

Registration methods can be loosely divided into the following classes: algorithms that use image pixel values directly, e.g.,correlation methods [2]; algorithms that use the frequency domain, e.g., Fast Fourier transform based (FFT-based) methods [3]; algorithms that use low level features such as edges and corners, e.g., Feature based methods [1]; and algorithms that use high-level features such as identified (parts of) objects, or relations between features, e.g., Graph-theoretic methods[1].

The next step, following registration, is image stitching. Image integration or image stitching is a process of overlaying images together on a bigger canvas. The images are placed appropriately on the bigger canvas using registration transformations to get the final mosaic. At this stage, the main concerns are in respect of the quality of the mosaic and the time efficiency of the algorithm used.

Image Blending is the technique, which modifies the image gray levels in the vicinity of a boundary to obtain a smooth transition between images by removing these seams and creating a blended image by determining how pixels in an overlapping area should be presented. The term image spline refers to digital techniques for making these adjustments. A good image spline makes the seam perfectly smoth, yet preserves as much as the original information as possible.

II. DESIGN METHODOLOGY



III. FEATURE POINT EXTRACTION

A) The Idea of Harris Corner

The first step in the image mosaic process is feature detection. Therefore we introduce Harris detector in our mosaic framework. Harris Corner detecting was a point feature extracting algo based on Moravec algorithm by C.Harris and M.J Stepens in 1988. Its main idea is to design a local detecting window in image. when the window moves in each direction the average grey variation of the window is more than threshold, then the center point of the window is extracted as corner point. When we just shift one pixel in an image that can create a significant change in the corner.

Let the grey of pixel (u,v) be I(x,y) then the grey variation of pixel (x,y) with a shift (u,v) can be denoted as :

$$E(u,v) = \sum_{x,y} w(x,y)\left[I(x+u,y+v) - I(x,y)\right]^2$$

Applying Taylor series expansion we get,

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u,y+v) - I(x,y)]^2$$

$$= \sum_{x,y} w(x,y)[I_x u + I_y v + O(u^2,v^2)]^2$$

For small shifts [u, v] we have the following approximation,

$$E(u,v) \cong [u,v] \quad M \quad \begin{bmatrix} u \\ v \end{bmatrix}$$

Where M is a 2×2 matrix computed from image derivatives:

Measure of corner response:

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

Let λ_1, λ_2 be the eigen values of M, then the flat area, corner and edge of the image can be detect by the eigen values as followed.

- Flat area: both λ_1, λ_2 are tiny.
- Edge: one of λ_1, λ_2 is smaller and the other is bigger.
- Corner: both λ_1, λ_2 are bigger and are nearly the equal.

To extract the corner, Harris constructed the formula as:

$$R = \det M - k(\text{trace}\, M)^2$$

$$\det M = \lambda_1 \lambda_2$$

$$\text{trace}\, M = \lambda_1 + \lambda_2$$

IV. COMPUTING HOMOGRAPHIES

A) RANSAC algorithm:

First of all we need to know what RANSAC (Random Sample Consensus) actually mean before going into the details of homography. Generally we use RANSAC algorithm for fitting of models in presence of many available data outliners in a robust manner. Given a fitting problem with parameters $\vec{x}$, it estimates the parameters considering the following assumptions.

1. Parameters can be estimated from N data items.
2. Available data items are totally M.
3. The probability of a randomly selected data item being part of a good model is P_g.
4. The probability that the algorithm will exit without finding a good fit if one exists is P_{fail}.

Then, the algorithm:

1. Selects N data items at random
2. Estimates parameter $\vec{x}$
3. Finds how many data items (of M) fit the model with parameter vector $\vec{x}$ within a user given tolerance. Call this K.
4. If K is big enough, accept fit and exit with success.
5. Repeat 1..4 L times
6. Fail if you get here

How big K has to be depends on what percentage of the data you think belongs to the structure being fit and how many structures you have in the image. If there are multiple structures then, after a successful fit, remove the fit data and redo RANSAC.

We can find L by the following formulae:

P_{fail} = Probability of L consecutive failures

P_{fail} = (Probability that a given trial is a failure)L

P_{fail} = (1 - Probability that a given trial is a success)L

P_{fail} = (1 - (Probability that a random data item fits the model)N)L

$$P_{fail} = (1 - (P_g)^N)^L$$

$$L = \frac{\log(P_{fail})}{\log(1-(P_g)^N)}$$

B) Homography:

It's nothing but a mapping between two spaces which often used to represent the correspondence between two images of the same scene. It's widely useful for this project where multiple images are taken from a rotating camera having a fixed camera center ultimately warped together to produce a panoramic view.

Let's take a situation of projection transformation of planes in images. We have two cameras C1 and C2 looking at a plane π in the world. Consider a point P on the plane π and its projections.

p= $(u1,v1, 1)^T$ in image1 and q= $(u2,v2, 1)^T$ in image2. There exists a unique (up to scale) 3 × 3 matrix H such that, for any point P:

$$q \equiv Hp \qquad (1)$$

(Here ≡ implies the left and right hand sides are proportional and those homogeneous coordinates are trivially equal)

As mentioned earlier H only depends on the plane and the projection matrices of the two cameras and being a projective transformation matrix can be only defined up to a scale.

Lastly to say, as q and Hp are only proportional to each other so equivalently we have

$$q \times Hp = 0 \quad (2)$$

This H is a projective transformation of the plane, also referred to as a homography.

Since the matrix H has 8 DOF, 4 point correspondences determine H.

Thus, H is estimated with a minimization scheme using:

$$h = (h11; h12; h13; h21; h22; h23; h31; h32; h33)T \quad (3)$$

N point correspondences give 2N linear constraints, using (2). This results in a system of the form Bh = 0. The following problem must then be solved:

$$\min_h \|Bh\|^2 \text{ subject to } \|h\| = 1 \quad (4)$$

The Homography Detection Algorithm using RANSAC scheme

1. First corners are detected in both images.
2. Variance normalized correlation is applied between corners, and pairs with a sufficiently high correlation score are collected to form a set of candidate matches.
3. Four points are selected from the set of candidate matches, and a homography is computed using (2).
4. Pairs agreeing with the homography are selected. A pair (p, q), is considered to agree with a homography H, if for some threshold ²:
   dist (Hp, q) < ∈
5. Steps 3 and 4 are repeated until a sufficient number of pairs are consistent with the computed homography.
6. Using all consistent correspondences, the homography is recomputed by solving (4).

V. IMAGE WARPING AND BLENDING

A) Image warping

The last step is to warp and blend all the input images to an output composite mosaic. Basically we can simply warp all the input images to a plane defined by one of them known as reference image. The output in this case is known as composite panorama.

1. First we need to make out the output mosaic size by computing the range of warped image coordinates for each input image, as described earlier we can easily do this by mapping four corners of each source image forward and computing the minimum x, minimum y, maximum x, and maximum y coordinates to determine the size of the output image. Finally x-offset and y-offset values specifying the offset of the reference image origin relative to the output panorama needs to be calculated.
2. The next step is to use the inverse warping as described above for mapping the pixels from each input image to the plane defined by the reference image, is there to perform the forward and inverse warping of points, respectively.

B) Image blending:

The final step is to blend the pixel colors in the overlapped region to avoid the seams. Simplest available form is to use feathering, which uses weighted averaging color values to blend the overlapping pixels. We generally use alpha factor often called alpha channel having the value 1 at the center pixel and becomes 0 after decreasing linearly to the border pixels. Where at least two image overlap occurs in an output mosaic we will use the alpha values as follows to compute the color at a pixel in there, suppose there are 2 images, I1, I2, overlapping in the output image; each pixel (x, y) in image I_i is represented as $I_i(x, y) = (\alpha iR, \alpha iG, \alpha iB, \alpha j)$ where (R, G, B) are the color values at the pixel. We will compute the pixel value of (x, y) in the stitched output image as $[(\alpha 1R, \alpha 1G, \alpha 1B, \alpha 1) + (\alpha 2R, \alpha 2G, \alpha 2B, \alpha 2)] / (\alpha 1+\alpha 2)$.

VI. EXPERIMENT

The algorithm proposed in the paper has been implemented in Matlab 7.1 fig 2 shows the result of image mosaic of the experiment. Fig (a) and Fig (b) is an input image. Fig 2(a) and 2(b) is the corner detecting result of image (a) and image (b) by using Harris corner detecting algorithm. In the experiment the sum of matched corner pair is 220 and the correct matched pair is 190 .The efficient matched ratio is about 95% . As shown in fig the result of image mosaicing and image fusion is effective.

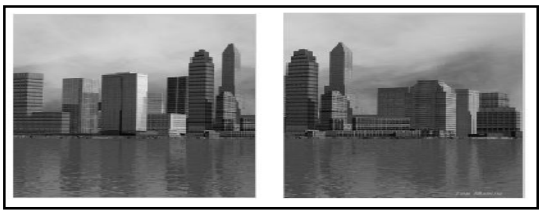
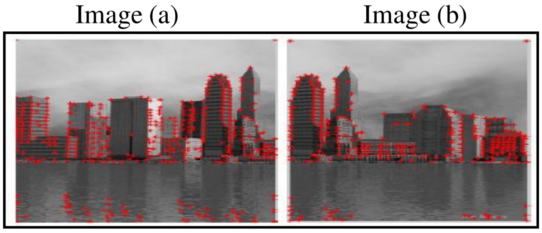


Image (a) Image (b)



Corner in : Image(a) Image (b)

Final output Mosaic Image

VII. CONCLUSION

An Harris corner detecting method is proposed to extract the corner which need not set the threshold by manual and is in sensitive to isolated point, noise and edge. So it can avoid corner redundant or lost brought by uncertain threshold selection and improve the precision of corner detecting more ever by using the advantage of RANSAC in parameter estimation, which can remove the false matched corner pair effectively and improve the corner matched ratio. Experiment shows the proposed algorithms has achieved well result.

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