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Automatic Seamless of Image Stitching

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Abstract

The objective of this paper is to implement image stitching by adopting feature-based alignment algorithm and blending algorithm to produce a high quality image, the images for stitching to create panorama are captured in a fixed linear spatial interval. The processing method involves feature extraction, image matching based on Harris corner detectors method as the feature detection and neighboring pairs alignment using RANSAC (RANdom Sample Consensus) algorithm. Linear blending is applied to remove the transition between the aligned images. The presented image stitching algorithm is successfully able to create panorama image.

Keywords: Image stitching, Harris detectors, RANSAC algorithm, Linear blending.

1. Introduction

Image stitching is the process that combines multiple images to form a single one with a wide field of view, the essential aims of stitching are to increase image resolution as well as the field of view, People used image stitching technology in topographic mapping. Image stitching algorithms create the high resolution photo-mosaics used to produce today's digital maps and satellite photos. Creating high resolution images by combining smaller images are popular since the beginning of the photography**.** There should be nearly exact overlaps between images for stitching and common region between images. The images of same scene will be of different intensities, scale and orientation, stitching should work or at least give visually appealing output, and normally the process of image stitching is divided into three steps (Brown, L.G 1992): image registration and image merging and blending. During the image registration, multi-images are compared to find the translations that can be used for the alignment of images. After registration, these images are merged together to form a single image. This step of image merging is performed to make the transition between adjacent images visually undetectable. In most cases neighboring image edges show undesirable intensity discrepancies. These variations in intensity are present even when registration of two images is almost perfect to the eye. In order to eliminate such effects and improve visual quality of the composite image, a blending algorithm is applied. The blending is to choose the final value of a pixel in a location where two images are overlapping. In this work feature based method used instead of area based method, first Harris corner detector algorithm used to detect feature point in image then matching these points by correlation methods and eliminate the error correlated points in images by RANSAC algorithm , After that we apply the blended method to get blended image. At the end we got good results. The algorithms used in this work are described in detail in the section two, section three presents the implemented results. Conclusion is addressed in section four.

2. Literature Review

This section surveys previous work in image stitching. The algorithms for aligning images and stitching them into seamless photo mosaics are the oldest and most widely used in computer vision. The first image stitching concept was known to be implemented to create panoramas in 1787 by Robert Barker, an Irishman, who created panoramas of a cylindrical building (Harald 2009).Xue Mei and Fatih Porikli 20have purposed a computationally inexpensive method for multi-modal image registration(Xue, Faith 2006). Their method employs a joint gradient similarity function that is applied only to a set of high spatial gradient pixels. They used the gradient ascent method to get the maximization of similarity function which gives the motion parameters for best match. The edge based Chamfer matching methods also became popular which used the edge information in the image for matching. In Chamfer matching, we select an image as template and try to match with other image using distance transform. We can use the various transformed templates to match rotated images. (D.M. Gavrila and V. Philomin 1999) implemented the Chamfer based matching method in real-time detection of traffic signs and pedestrians from a moving vehicle. They used coarse-to-fine approach over the shape hierarchy and over the transformation parameters to make the matching faster. More recent algorithms on image alignment extract a sparse set of feature points and match these points to each other to get the motion parameters (Richard 2006).

Brown and Lowe discuss on obtaining the invariant local features to find the matches between the images and they also claim the method to be insensitive to ordering, orientation, scale and illumination of input images(Matthew Brown , David Lowe2002). And there are several research papers which discuss on extracting the feature points in the image. Some basic corner detectors including Harris have been discussed by Parks and Gravel (Donovan Parks and Jean-Philippe Gravel2011). Similarly, the very fast corner detectors (Features from Accelerated Segment Test) have been purposed by (Rosten et al 2006). The more robust feature points extractors (SIFT and SURF) has been discussed by Lowe (David G Lowe 2008) and Bay et al (Herbert Bay 2008). The authors of the papers claim that those feature extractors are more robust and invariant to image rotation, scale or intensity changes.

3. Panorama Image Stitching Algorithm

The steps we used in the implementation of panorama image stitching includes: 2.1 Images acquisition; 2.2 Features detection based on harris detector method, 2.3 RANSAC and 2.4 Image blending which can be described as Figure 1. More details of each step will be discussed

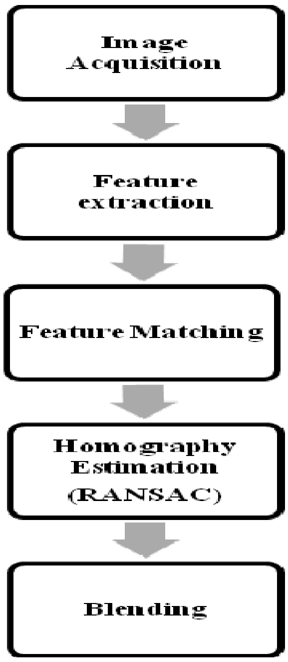

Figure 1: The entire process of panorama image stitching

3.1 Images acquisition

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement ,The captured images are assumed to have enough overlap with each other, the camera parameters are known and the focal length is to be a fix value. The shooting process of the image sequences is designed using orientation sensor information, so that the user only needs to move the camera spatially and the pictures will be captured automatically with sufficient overlaps.

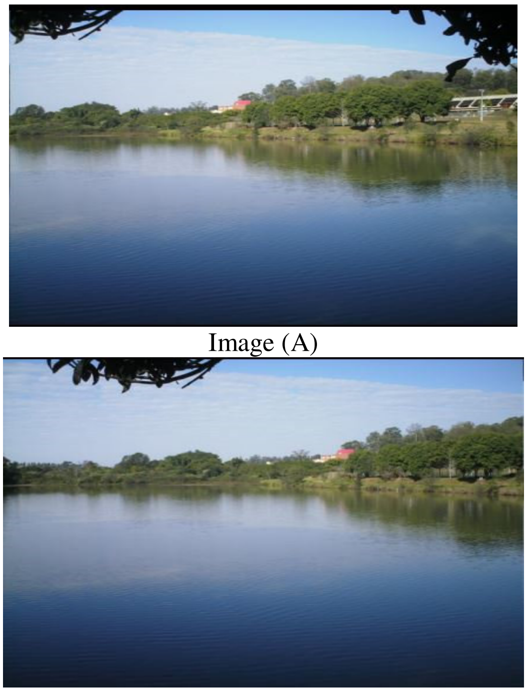

Image (A)

Image (B)

Figure 2: Image (A) and Image (B) represent Image acquisition in same scene with different angle

3.2 Feature Detection

Finding the correct feature points is fundamental to perform a right stitching. It's crucial to choose the correct detector of this point, In order to create our image stitching, the general idea will consist in identifying common points between the two images and then projecting one of the images on top of the other in an effort to match those points. Harris corner detector (Chris &Mike Stephens 1988) is a popular interest point detector due to its strong invariance to: rotation, scale, illumination variation and image noise. Harris corner detection algorithm is realized by calculating each pixel's gradient If the absolute gradient values in two directions are both great, then judge the pixel as a corner**.** This operator was invented by Chris Harris and Mike Stephens's in1988, it was only a processing phase to analyze a robot's environment represented by images. The general steps that are required to implement the Harris corner detection are:

1. For each pixel (x,y) in the image, calculate the auto correlation matrix M as follows:

$$M = \begin{bmatrix} A & C \\ C & B \end{bmatrix} \qquad \textbf{(1)}$$

Where

$$A=\left(\frac{\partial I}{\partial x}\right)^2 \otimes \omega \text{ , } B=\left(\frac{\partial I}{\partial y}\right)^2 \otimes \omega \text{ , } C=\left(\frac{\partial I}{\partial x}\frac{\partial I}{\partial y}\right)^2 \otimes \omega$$

2. Construct the cornerness map by calculating the cornerness measure Cornerness(x, y) for each pixel (x,y):

$$Cornerness(x,y)= det(M) - K(trace(M))^2 \qquad \textbf{(2)}$$

Where

$$det(M) = AB-C^2$$
$$trace(M) = A+B$$

k=a constant (generally, k between 0.04 to 0.06 gives good result) Where (*Cornerness (x,y)*) determines the

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strength of the corner and K is constant chosen to be 0.04.This function is usually compared against a threshold to give a desired number of corner points.

3. Threshold the interest map by setting all Cornerness (x,y) below a threshold T to zero. The number of corners depends upon the selected threshold T, decreasing T results increment in corners.

4. Perform non-maximal suppression to find local maxima. The non-zero point remaining in the cornersness map is corners. An example of calculated Harris between two image pairs is shown in Fig.3. After the features are detected using Harris method, the feature correspondences between given image pairs are matched by considering the nearest Euclidean distance

search over the entire features that are detected. The Homography (H) model of the projective transform is set up an equation with the unknown parameters of H as described in Equation

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The transformation is described by homograph matrix with the parameters a, b, c, d, e, f, g, h, and i. The scaling factor i can be set to 1, hence there are 8 unknowns to be solved.

Image (A)

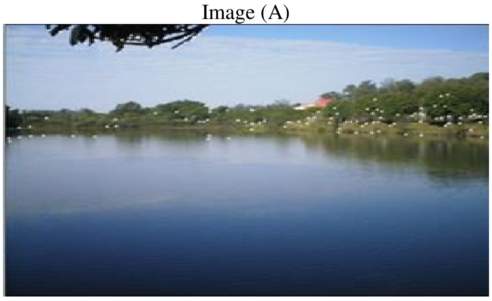

Image (B)

Figure 3: Image (A) and Image (B) represent feature detection

3.3 Feature Matching

After our interest points have been detected, we need to match points by correlate them. A maximum correlation rule is used in order to determine matches between our two images. The cross-correlation works by analyzing a window of pixels around every point in the first image and correlating them with a window of pixels around every other point in the second image. Points which have maximum bidirectional correlation will be taken as corresponding pairs, some of these correspondences are not true in reality. The RANSAC algorithm applied later will be used to eliminate these mismatches.

Figure 4: Images with feature points correlated ("Inlier" and "Outlier")

3.4 RANSAC (RANdom Sample Consensus)

RANSAC is the acronym of "RANdom SAmple Consensus". This filtering algorithm was published by Fischler and Bolles in 1981 It is a non-deterministic algorithm, because it doesn't ensure to return acceptable results, the probabilities of success increases if more iteration is made (Matthew Brown 2002). It is used to estimate parameters for homography and translation model, while homography is used to describe the relationships between over-lapping images in planar coordinates and translation for cylindrical coordinates (Ye Ji 2011).This step is to estimate a model that minimizes matching error. The idea is to compare the probabilities that this consensus set of inliers/outliers generated by a correct image match or a false image match (Richard Hartley 2000) RANSAC loop involves:

1. A random sample of 4 correspondences is selected.
2. Computing transformation from those four correspondences.
3. Finding inliers to this transformation.
4. If the number of inliers is sufficiently large, re-computing transformation on all of the inliers.

Figure 5: Images after execution of RANSAC (only "Inlier")

3.5 Image Blending

The final step to stitch two images is to blend these images together. To do so, we will be using a linear gradient alpha blending from the centre of one image to the other. The gradient blending (Vladan Rankov 2005) works by change in one image's alpha channel over the line which connects the centers of the two images. The image gradients from each source image are copied in a second pass, an image that best matches these gradients is reconstructed [69]. Gradient blending is simple but effective algorithm. Gradient blending assigns the weight values (i.e. α) to the pixels of the overlapping area. For α =0.5, we get simple averaging, where both the overlapped areas will contribute equally to create stitched image. The value of α ranges from 0 to 1, if α =0, then the pixel has no effect in composite region while α =1 implies the pixel is copied there. Suppose, composite image *I* is created from horizontally aligned images *I1* (left) and *I2* (right), then

$$I = \alpha I_1 + (1 - \alpha) I_2 \qquad \textbf{(3)}$$

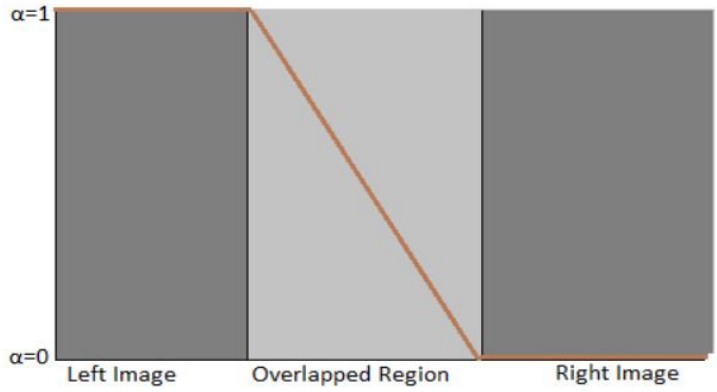

Figure 6: gradient blending: α decreases from 1 to 0 in the overlapping region

The above figure is for horizontally aligned images, and similar technique can be used for vertically aligned images. If alignment is both horizontal and vertical, then left, right, top and bottom regions of the blending region will have effect in blending. Gradient blending technique works well if the intensities of images *I1* and *I2* are similar. The advantage of gradient blending is its simplicity and we can tweak it to make it faster after the blending filter has been applied, we will finally have our result as shown in the image below:

Figure 7: Final images resulting from the blending of the two consecutive images

4. Results

Our paper uses one image sequence sampling, which includes two images in size of 640 X480, including a noise image, shown as figure2. And the result of automatic image stitching is shown as figure7.Seeing from the figures7, our method is well effective, faster and always guaranteed to give accurate result.

5. Conclusions

The automatic image stitching is successfully implemented using an image sequences captured by camera. Harris corner detector used in this work because is good for faster detection of corners in the image, and gives accurate corners if the images to be stitched have different intensity or orientation. The aim is to extract corners feature and use a normalized cross-correlation of the local intensity values in particular points to match them, Having correlated feature points between the two images, it can determine a model that can convert points of one image to the other by a homography matrix, It gives the possibility to overlap two images according position of correlated feature points, Then is used a probabilistic algorithm RANSAC (RANdom Sample Consensus) that returns acceptable results if more iteration is made distinguishing two types of data: “Inlier” and “Outlier” The RANSAC method is preferable for robust estimation of homography because it works quite effectively even if we have a lot of false matches, A linear gradient alpha blending is chosen for blending which is faster and gives more accurate results, the method is effective because it successfully removes the seams and discontinuities on the composite image.

6. Future Works

In the future, one can try to use image stitching in GPS map, the geo-registration method can be used to obtain every point GPS location and stitch all points together to obtain a full map of GPS. This new way of geo-registration is a non-feature based geo-registration, also Future work can include an algorithm to develop image stitching in order to present the system of 360 degree view in 3D image.

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