"IMPLEMENTATION IMAGE MOSAI USING PHASE CORRELATION AND HARRIS OPERATOR"

[1]Ms. Kanchan S.Tidke, [2]Pritam H. Gohatre
[1]GH Raisoni Amravati, India
k10tidke@gmail.com
[2]LAMIT, Dhamangoan (Rly), India
pritamgohatre@gmail.com

ABSTRACT: *Image mosaic is a technique used to composite two or more overlapped images into a seamless wide-angle image through a series of processing and it is widely used in remote sensing areas, military applications, etc. When taking these photos, it's difficult to make a precise registration due to the differences in rotation, exposure and location. The image mosaic techniques are widely used in remote sensing, medical imaging, and military purposes and so on. Now days, many smart phones are equipped with the mosaicing application which helps user in many different ways. The image mosaicing technique can be broadly classified into feature-based and frequency-based techniques. Feature-based method uses the most similarity principle among images to get the parameters with the help of calculation cost function. Method based on the frequency domain transforms the image from spatial domain to frequency domain, and get the relationships of translation, rotation and zoom factor through Fourier transformation. In frequency domain there are methods like phase-correlation, Walsh transform, etc.*

Keywords: Image mosaic, remote sensing, medical imaging, Feature-based method, frequency domain transforms, phase-correlation, Walsh transform.

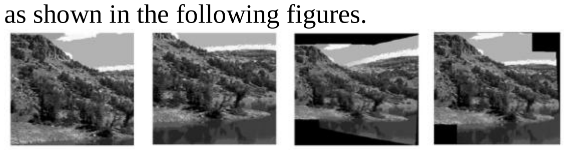
1. INTRODUCTION

Algorithms for processing images and mosaic them into seamless photo-mosaics are among the oldest and most widely used in computer vision. Frame-rate image alignment is used in every camcorder that has an "image stabilization" feature. Image stitching algorithms create higher resolution photo-mosaics used to produce today's digital maps and satellite photos. They also come bundled with most digital cameras currently being sold, and can be used to create beautiful ultra wide-angle panoramas.
In day to day life and work sometimes there is a need for wide angle and high resolution panoramic images, which the ordinary camera equipment cannot reach. However, it is not feasible as far as the issues like whole scene, professional photographic equipment, high price of maintenance convenient for operation, lack of technical personnel and unsuitability of general uses are concerned, and hence the use of image mosaicing techniques has been put forward.

2. MOTIVATION

Currently the image mosaicing technique has become the popular computer graphics research. Also image mosaic has been efficiently and precisely applied to areas such as industry, military, and health care. Technique of image mosaic for restoring images with larger visual angle and more reality plays an essential role in detecting more information from the image. In fact, to the limit of objective conditions, i.e. equipments or weather, images are usually unable to reflect the full scene, which makes it more difficult for the further processing of those images. The general task of image mosaic is to build the images in way of their aligning series which overlaps in space. Compared with single images, scene images built in this way are usually of higher resolution and larger vision.

Image mosaic aims to combine a set of images, normally overlapped, to form a single image as shown in the following figures.



(a) **(b)** **(c)** **(d)**

Figure 1: An overview of Image Mosaicing (a) First input image (b) Second input image (c) & (d) Mosaiced images by different mosaic techniques.

Figure (a) and Figure (b) are the input images, while Figure (c) and Figure (d) are Mosaiced images.

3. OBJECTIVE

In this work we have used a technique which combines both namely the feature-based method and frequency-domain method for image Mosaicing. The feature-based method used is the Harris corner detection and the frequency-domain method used is the Fourier transform-based cross-correlation or phase correlation method.

4. LITERATURE SURVEY

The original image alignment algorithm was the Lucas-Kanade algorithm. The goal of Lucas- Kanade is to align a template image to an input image, where is a column vector containing the pixel coordinates. If the Lucas-Kanade algorithm is being used to compute optical flow or to track an image patch from time to time, the template is an extracted sub-region (a window, maybe) of the image [1].

Algorithms for aligning images and stitching them into seamless photo-mosaics are among the oldest and most widely used in computer vision. Frame-rate image alignment is used in every camcorder that has an “Image Stabilization” feature. Image stitching algorithms create the high- resolution photo-mosaics used to produce today’s digital maps and satellite photos. They also come bundled with most digital cameras currently being sold, and can be used to create beautiful ultra wide-angle panoramas.

An early example of a widely used image registration algorithm is the patch-based translational alignment (optical flow) technique developed by Lucas and Kanade [1]. Variants of this algorithm are used in almost all motion-compensated video compression schemes such as MPEG [3]. Similar parametric motion estimation algorithms have found a wide variety of applications, including video summarization [4][5], video stabilization [8], and video compression [9][10]. More sophisticated image registration algorithms have also been developed for medical imaging and remote sensing. In the photogrammetric community, more manually intensive methods based on surveyed ground control points or manually registered tie points have long been used to register aerial photos into large-scale photo-mosaics [11]. One of the key advances in this community was the development of bundle adjustment algorithms that could simultaneously solve for the locations of all of the camera positions, thus yielding globally consistent solutions [12]. One of the recurring problems in creating photo-mosaics is the elimination of visible seams, for which a variety of techniques have been developed over the years [13]-[17].

In film photography, special cameras were developed at the turn of the century to take ultra wide-angle panoramas, often by exposing the film through a vertical slit as the camera rotated on its axis [18]. In the mid-1990s, image alignment techniques were started being applied to the construction of wide-angle seamless panoramas from regular hand-held cameras [19]-[22]. More recent work in this area has addressed the need to compute globally consistent alignments [23]-[25], the removal of “ghosts” due to parallax and object movement [26][27], and dealing with varying exposures. These techniques have spawned a large number of commercial stitching products, for which reviews and comparison can be found on the Web.

While most of the above techniques work by directly minimizing pixel-to-pixel dissimilarities, a different class of algorithms works by extracting a sparse set of features and then matching these to each other. Feature-based approaches have the advantage of being more robust against scene movement and are potentially faster, if implemented the right way. Their biggest advantage, however, is the ability to “recognize panoramas,” i.e., to automatically discover the adjacency (overlap) relationships among an unordered set of images, which makes them ideally suited for fully automated stitching of panoramas taken by casual users.

By the year 2011, at University of Victoria, Canada in Department of Electrical and Computer Engineering, Ioana S. Sevcenco, Peter J. Hampton and Pan Agathoklis proposed a method of seamless stitching of images based on a haar wavelet 2d integration [28].

Recently, Chengcheng Liu and Yong Shi proposed SIFT algorithm for image registration. SIFT algorithm is obtained by judging the feature points of local extreme, combined with neighbourhood information to describe the feature points to form a feature vector, in order to build the matching relationship between the feature points.

An early example of a widely-used image registration algorithm is the patch-based translational alignment (optical flow) technique developed by Lucas and Kanade (1981). Variants of this algorithm are used in almost all motion-compensated video compression schemes such as MPEG and H.263 (Le Gall 1991). Similar parametric motion estimation algorithms have found a wide variety of applications, including video summarization (Bergen et al. 1992a, Teodosio and Bender 1993, Kumar et al. 1995, Irani and Anandan 1998), video stabilization (Hansen et al. 1994), and video compression (Irani et al. 1995, Lee et al. 1997). More sophisticated image registration algorithms have also been developed for medical imaging and remote sensing—see (Brown 1992, Zitov'aa and Flusser 2003, Goshtasby 2005) for some previous surveys of image registration techniques.

In the photogrammetry community,moremanually intensivemethods based on surveyed ground control points or manually registered tie points have long been used to register aerial photos into large-scale photo-mosaics (Slama 1980). One of the key advances in this community was the development of bundle adjustment algorithms that could simultaneously solve for the locations of all of the camera positions, thus yielding globally consistent solutions (Triggs et al. 1999). One of the recurring problems in creating photo-mosaics is the elimination of visible seams, for which a variety of techniques have been developed over the years (Milgram 1975, Milgram 1977, Peleg 1981, Davis 1998, Agarwala et al. 2004).

According to the comparison and analysis above, aiming at the mosaic between images that have larger scale difference, we try to synthesize the advantages both in frequency dispose and registration with features, a new robust method combined the phase-correlation and Harris corner is proposed. We can get the factor of translation and zoom by cross-power spectrum in order to optimize the detection of Harris. The feature detection then can be restricted in based on phase-correlation. First, we detect the zoom relationship and translation co-efficiency between the images and modulate the unregistrated image's scale to the same level as the original image. We obtain the Region of Interest (ROI) according to the translation parameter and then pre-treat the images and mark the interest points in the area by using improved Harris corner operator. Secondly, we adopt Normalized Cross-Correlation (NCC) to wipe out the mismatched points preliminary after edging process, and get the final precise transformation matrix. At last, we are using a method of weighted average to obtain a smooth mosaic image. The experimental results have shown that the setting of ROI and handling of the edge could cut the time down to about only half of the time consuming compared to SIFT. Besides, the scale difference between the images could enlarge from 1.8 to 4.7 and can eventually obtain a clear and stable mosaic result.

The translation, scale and rotation in the available set of images are handled in the following way. Initially Phase correlation algorithm is used to calculate the cross-power spectrum for registration of images and is used to get the translation factor. For images that have relative relationships in location and the overlapped area to avoid the waste of resource in irrelevant area when we do the search work. More importantly, this method can eliminate the non-adaptive weakness because of scale change. It is superior to SIFT and original Harris algorithm in terms of the calculation speed and applicability.

5. PROBLEM DEFINITION

By keeping following things in mind as an objective, we are expecting best results from this approach of mosaicing.

- To propose a better mosaicing method, which can stitch scattered images together of the same scene (or target), so as to restore an image (or target) without losing a prior information in it.
- To increase an accuracy and reduce the time to mosaic the images which will shows better efficiency as compared to other mosaicing techniques.

6. METHODOLOGY

In order to improve the method of harris corner, we present an auto-adjusted algorithm of image size

scale, we can also get the zoom factor and rotation angle through a series of coordination transform.

Feature extraction method:

The original Harris corner detection method has some disadvantage that, even though it is robust to the illumination changes and rotations, it is very sensitive to the variation of image size. In addition, by doing a direct corner checking to images whose textures are dense or who have abundant details, we surely would get duplicate features in a local area. Inevitably, we must do extra work to extract and registration the points, including the useless ones. So additional preprocessing the image before extraction can offer a possibility to get more stable features. The improvement is done in the following way:

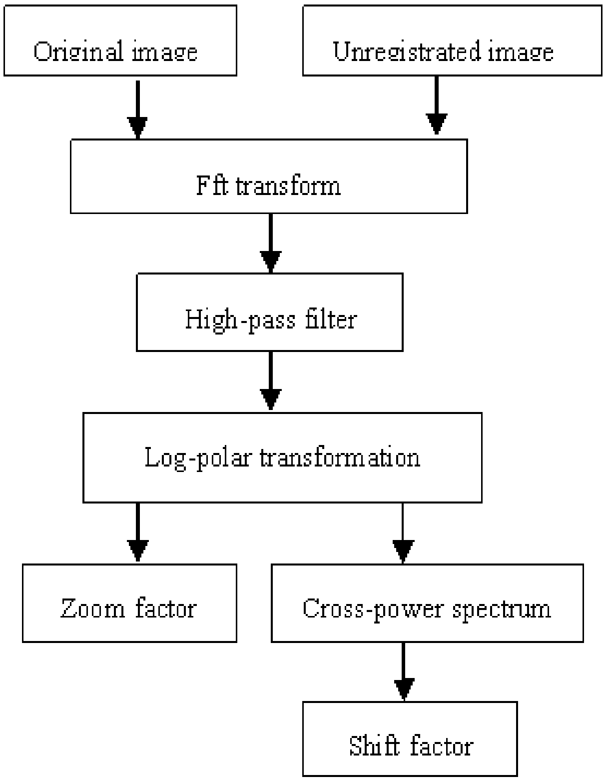


Figure 2: Flowchart to compute the factors

Step 1: Get the shift and zoom factors with the help of phase correlation calculation.
Step 2: Modulate the unregistrated image according to the zoom factor obtained from step 1 to get a couple of images with the same size.
Step 3: Ascertain the ROI (Region Of Interest) between the images.
Step 4: Preprocess image before other works. The edge detection can reduce the search area and can greatly cut the matching-time down.

7. IMPLEMENTATION

Phase correlation algorithm uses the cross-power spectrum to registration images and is used to get the translation factor initially. Imagine there are two images I_1 and I_2, and the translation between them is as following:
The Fourier transformation:

$$I_2(x,y) = I_1(x - x_0, y - y_0)$$

$$F_2(u,v) = F_1(u,v) \cdot e^{-j(ux_0+vy_0)}$$

F1 and F2 are the Fourier transformation of I1 and I2.

$$\frac{F_1 * (u,v) F_2(u,v)}{|F_1 * (u,v) F_2(u,v)|} = e^{-j(ux_0+vy_0)} \quad (3)$$

The Cross-power spectrum is: We can get an impulse function $\delta(x - x_0, y - y_0)$ about the value of translation invariant x_0 and y_0 by using Fourier inverse transform to equation (3).

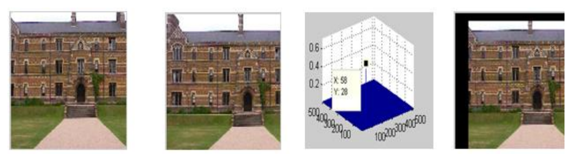
Feature Extraction

EXTRACTION OF HARRIS CORNER

In this paper, we get the corner response function by the ratio from the determinant and trace of matrix M, which can avoid the randomness when choosing the scale factor compared to the method based on the difference value of the above ones. Besides, just as the experiments show, we could get much more stable features along with a speed-up procedure.

$$R = \frac{Det(M)}{trace(M)} = \frac{\langle I_x^2 \rangle \cdot \langle I_y^2 \rangle - \langle I_x I_y \rangle^2}{\langle I_x^2 \rangle + \langle I_y^2 \rangle}$$

8. RESULTS



(a) Image A (b) Image B (c) Detection of Phase correlation (d) Aligned Ima

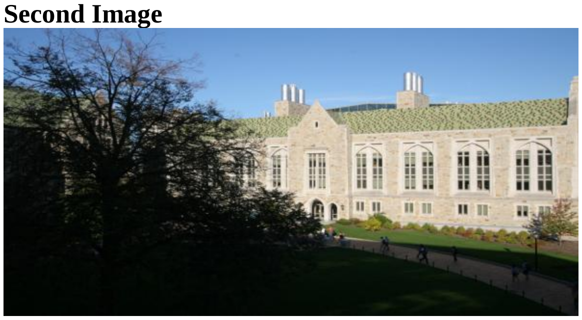
MATLAB OUTPUT

Fig. 3 is an experiment to get the range shift of the given input images i.e Image A and Image B, by using phase correlation algorithm. The preset value between image A and B is (58, 28). So we can get the shift value via the location of the maximum value.

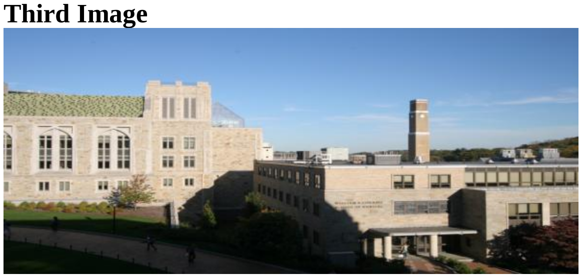
EXPERIMENTAL RESULT

We load three distinct images one by one. For the mosaic
First Image

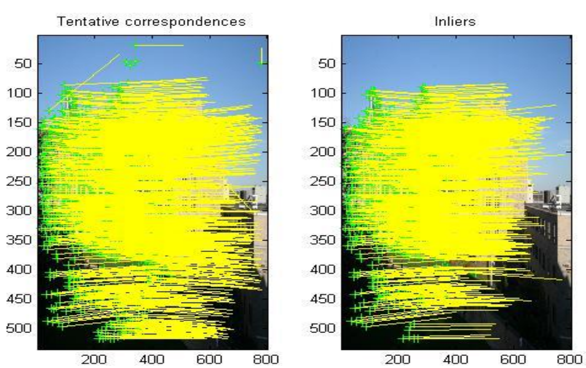
Second Image



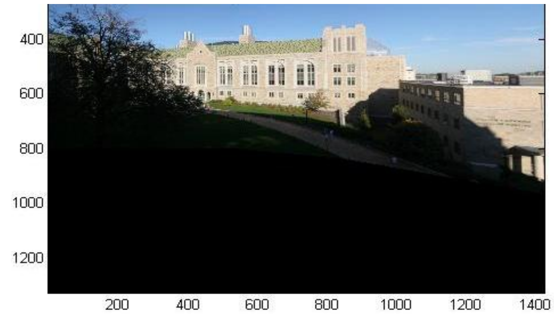
Third Image



Set of tentative correspondences (pairs of matched points between two images) are shown below.



Final Image after Mosaicing



9. CONCLUSION

An approach for image mosaic based on phase-correlation and Harris operator is obtained through this project. First the scaling and translation relationship is gained according to the correlation method known as phase-correlation. Then the unregistrated image is adjusted and the ROI scope of matching is kept limited all according to the factors derived. Finally the feature points are detected and matched just in this area, based on the improved Harris corner. We comprehensively apply the advantages of spatial and frequency domain to conquer Harris's maximum inadequacies for not possessing the scale-invariant quality, and also we have enhanced robustness. As a result, the setting of ROI and adoption of preprocessing avoid the useless extraction and registration which leads to additional speed-ups and improvement of the precision.

10. FUTURE SCOPE

While image stitching is by now a fairly mature field with a variety of commercial products, there remain a large number of challenges and open extensions. One of these is to increase the reliability of fully automated stitching algorithms. As discussed earlier, it is difficult to simultaneously avoid matching spurious features or repeated patterns while also being tolerant to large outliers such as moving people. Advances in semantic scene understanding could help resolve some of these problems, as well as better machine learning techniques for feature matching and validation. The problem of parallax has also not been adequately solved. For small amounts of parallax, the deghosting techniques can often adequately disguise these effects through local warping and careful seam selection. For high-overlap panoramas, concentric mosaics concentric mosaics (Shum and He 1999), panoramas with parallax (Li et al. 2004b) and careful seam selection (with potential user guidance) (Agarwala et al. 2004) can be used. The most challenging case is limited overlap panoramas with large parallax, since the depth estimates needed to compensate for the parallax are only available in the overlap regions.

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12. AUTHOR PROFILE

Ms. Kanchan S.Tidke, received the Master of Engineering in Electronics and Tele-communication from Sant Gadge Baba Amravati University, Amravati. Currently She is an Assistant. Professor in Govt. Polytechnic, Amravati, India. She has published two papers in international journals. She is having 4 year teaching experience and his field of specialization is Image processing, VLSI, Embedded system and Networking.

Pritam H. Gohatre received the Master of Techonology in System Software from Rajiv Gandhi Technical University Bhopal. Currently he is an Assistant. Professor in LAMIT, Dhamangoan, India. He has published two papers in international journals. He is having 7 year teaching experience and his field of specialization is software development, Image processing, Networking.