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A REVIEW OF IMAGE MOSAICING METHODS

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ABSTRACT

Image Mosaicing is the process of combining two or more images of the same scene into one image and generate panorama of high resolution image. In this paper, we have described the basic methods used to generate panorama image. Our objective is to provide different methods and algorithms used to generate panoramic image. Mosaicing is one of the techniques of image processing which is useful for tiling digital images. Mosaicing is blending together of several arbitrarily shaped images to form one large radiometrically balanced image so that the boundaries between the original images are not seen. The output of image mosaic will be the union of two input images. In this paper we present a review on different approaches for image mosaicing.

KEYWORDS: Corners, Homography, Warping, Image Mosaicing, Registration, Stitching, Blending.

INTRODUCTION

Registration and mosaicing of images have been in practice since long before the age of digital computers. Shortly after the photographic process was developed in 1839, the use of photographs was demonstrated on topographical mapping. Images acquired from hill-tops or balloons were manually pieced together. After the development of airplane technology (1903) aero photography became an exciting new field. The limited flying heights of the early airplanes and the need for large photo-maps, forced imaging experts to construct mosaic images from overlapping photographs. This was initially done by manually mosaicing images which were acquired by calibrated equipment. The need for mosaicing continued to increase later in history as satellites started sending pictures back to earth. Improvements in computer technology became a natural motivation to develop computational techniques and to solve related problems.

In the digital realm, mosaics are illustrations composed by a collection of small images called 'tiles'. The tiles tessellate a source image with the purpose of reproducing the original visual information rendered into a new mosaic-like style. Computer generated Mosaic image creation is a new research area in recent years. Various mosaics can be created for an image depending on the choice of the tile dataset and the imposed constraints for positioning, deformations, etc. Mosaic images are images made by cementing together small colored tiles. Likely, they are the most ancient examples of discrete primitive based images. A picture (usually a photograph) is divided into (usually equal sized) small sections and each of which is replaced with another photograph that matches the target photo or reconstruct the image by properly painting the tiles. Mosaic images can be classified into four types, crystallization mosaic, ancient mosaic, photo mosaic, and puzzle image mosaic. The first two types of mosaics decompose a source image into tiles (with different color, size and rotation), reconstructing the image by properly painting the tiles. So they can be grouped together under the denomination of tile mosaics [6]. The last two kinds are obtained by fitting images from a database to cover an assigned source image. Hence they may be grouped together under the denomination of multi-picture mosaics [6]. This taxonomy should not be intended as a rigid one. Many mosaic techniques may fit in more than a single class and it is likely that other new types of mosaics will appear in the future.

Image mosaicing, the process of obtaining a wider field-of-view of a scene from a sequence of partial views, has been an attractive research area because of its wide range of applications, including motion detection, resolution enhancement, monitoring global land usage, and medical imaging. A number of image mosaicing algorithms have been proposed over the last two decades. This paper provides an in-depth survey of the existing image mosaicing algorithms by classifying them into several groups. For each group, the fundamental concepts are first explained and then the modifications made to the basic concepts by different researchers are explained.

RELATED WORK

Registration and mosaicing of images have been in practice since long before the age of digital computers. Shortly after the photographic process was developed in 1839, the use of photographs was demonstrated on topographical mapping. Images acquired from hill-tops or balloons were manually pieced together. After the development of airplane technology (1903) aero photography became an exciting new field. The limited flying heights of the early airplanes and the need for large photo-maps, forced imaging experts to construct mosaic images from overlapping photographs. This was initially done by manually mosaicing images which were acquired by calibrated equipment. The need for mosaicing continued to increase later in history as satellites started sending pictures back to earth.

Several image registration survey methods were proposed by many authors [1,2,3,4]. L.G. Brown published survey of image registration methods and he classified into four main methods based on type of problem, image acquisition, and applications. In the multimodal registration, images are acquired by different sensors of same scene. This method is used in medical image analysis and remote sensed data processing applications. Template registration finds a match for reference pattern in the sensed image.This registration method is used in object detection and recognition, character recognition and signature analysis.

In Feature Extraction and Matching It can be started with corner detection algorithms where we have described Harris, SUSAN, Forstner and SIFT algorithms.

In Harris Corner Detector Instead of using shifted patches, Harris and Stephens improved Moravec's corner detector by considering the differential of the corner score with respect to direction.

The corners or interest points may be interchanged and refers to point features in an image. The detected corner points correspond to the points in the two dimensional image with high curvature. Corners are declared at the junctions (meeting point) of two or more edges. Number of approaches for detecting corners such as Harris, SUSAN, KLT and FAST, etc.

Automated methods for image registration used in image mosaicing literature can be categorized as follows:

Feature based methods rely on accurate detection of image features. Correspondences between features lead to computation of the camera motion which can be tested for alignment. In the absence of distinctive features, this kind of approach is likely to fail.

Exhaustively searching for a best match for all possible motion parameters can be computationally extremely expensive. Using hierarchical processing (i.e. coarse-to-fine [13]) results in significant speed-ups. We also use this approach also taking advantage of parallel processing for additional performance improvement.

Frequency domain approaches for finding displacement and rotation/scale are computationally efficient but can be sensitive to noise. These methods also require the overlap extent to occupy a significant portion of the images (e.g. at least 50%).

Iteratively adjusting camera-motion parameters leads to local minimums unless a reliable initial estimate is provided. Initial estimates can be obtained using a coarse global search or an efficiently implemented frequency domain approach.

FEATURE EXTRACTION AND MATCHING

Harris Corner Detection Algorithm

This Algorithm was developed by Chris Harris and Mike Stephens in 1988 as a low level processing step to aid researchers trying to build interpretations of a robot's environment based on image sequences. Specifically, Harris and Stephens were interested in using motion analysis techniques to interpret the environment based on images from a single mobile camera. Like Moravec, they needed a method to match corresponding points in consecutive image frames, but were interested in tracking both corners and edges between frames. Harris and Stephens developed this combined corner and edge detector by addressing the limitations of the Moravec operator. The result was far more desirable detector in terms of detection and repeatability rate at the cost of requiring significantly more computation time. A local detecting window in image is designed. The average variation in intensity that results by shifting the window by a small amount in different direction is determined. At this point the center point of the window is extracted as corner point. We can easily get the point by looking at intensity values within a small window. Shifting the window in any direction gives a large change in appearance. Harris corner detector is used for corner detection. On shifting the window if it's a flat region than it will show no change of intensity in all direction. If an edge region is found than there will be no change of intensity along the edge direction. But if any corner is found than there will be a significant change of intensity in all direction. Harris corner detector gives a mathematical approach for determining whether the region is flat, or if there is an edge or corner. Harris corner technique is very much helpful in detecting more features and that technique is rotational invariant and scale variant.For image mosaicing we adopted a morphological approach for corner detection proposed in. The corresponding corner detector is based in an operation named asymmetrical close.

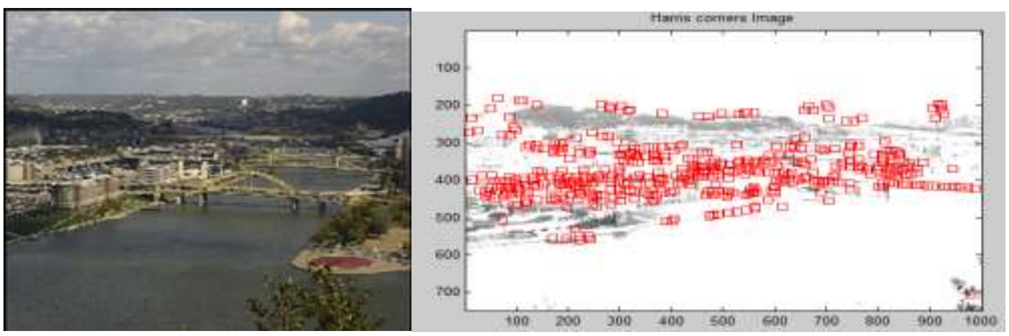

Fig.1 Circles indicate selected corner

A morphological close of an image first dilates it using a structuring element, followed by an erosion by the same element. In the asymmetrical close different structuring elements are used in the dilation and erosion. This operation is performed twice thereby using four different structuring elements and generating two intermediate images.

SIFT Algorithm

Scale Invariant Feature Transform termed as SIFT is used to identify locations and scales that can be repeatedly assigned under different views of the same object. Detecting locations that are invariant to scale changes of the image can be accomplished by searching for stable feature across all possible scales, using continuous function of scale known as scale space. Key-points are selected based on their stability. A stable key-point should be resistant to image distortion. In Orientation assignment SIFT algorithm computes the direction of gradients around the stable key-points. One or more orientations are assigned to each key-point based on local image gradient directions. For a set of input frames SIFT extracts features. Image matching is done using Best Bin First (BBF) algorithm for estimating initial matching points between input frames. To remove the undesired corners which do not belong to the overlapped area, RANSAC algorithm is used. It removes the false matches in the image pairs. Reprojections of frames are done by defining its size, length, width. Stitching is done finally to obtain a final output mosaic image. In stitching, each pixel in every frame of the scene is checked whether it belongs to the warped second frame. If so, then that pixel is assigned the value of the corresponding pixel from the first frame. SIFT algorithm is both rotational invariant and scale invariant.

RANSAC Algorithm

Calculating Homography is the third step of Image mosaicing. In homography undesired corners which do not belong to the overlapping area are removed. RANSAC algorithm is used to perform homography. RANSAC is an abbreviation for "RANdom Sample Consensus." It is an iterative method to estimate parameters of a mathematical model from a set of observed data which contains outliers. It is a non-deterministic algorithm in the sense that it produces a reasonable result only with a certain probability, with this probability increasing as more iterations are allowed. The algorithm was first published by Fischler and Bolles. RANSAC algorithm is used for fitting of models in presence of many available data outliners in a robust manner. Given afitting problem with parameters considering the following assumptions.

Fig.2 Images after execution of RANSAC

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 Pg.
4.The probability that the algorithm will exit without finding a good fit if one exists is Pfail.

Then, the algorithm:
1. Selects N data items at random.
2. Estimates parameter x.
3. Finds how many data items (of M) fit the model with parameter vector 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 we think belongs to the structure being fit and how many structures we have in the image. If there are multiple structures than, after a successful fit, remove the fit data and redo RANSAC.

We can find L by the following formulae:
Pfail= Probability of L consecutive failures.
Pfail= (Probability that a given trial is a failure) L.
Pfail= (1 -Probability that a given trial is a success)L.
Pfail= (1-(Probability that a random data item fits the model)N)L.

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

$$L = log(Pfail)/\ log(1-(Pg)N)$$

IMAGE MOSAICING PROCESS

The image mosaicing procedure generally includes three steps. First, we register input images by estimating the homography, which relates pixels in one frame to their corresponding pixels in another frame. Second, we warp input frames according to the estimated homographies so that their overlapping regions align. Finally, we paste the warped images and blend them on a common mosaicing surface to build the panorama result.

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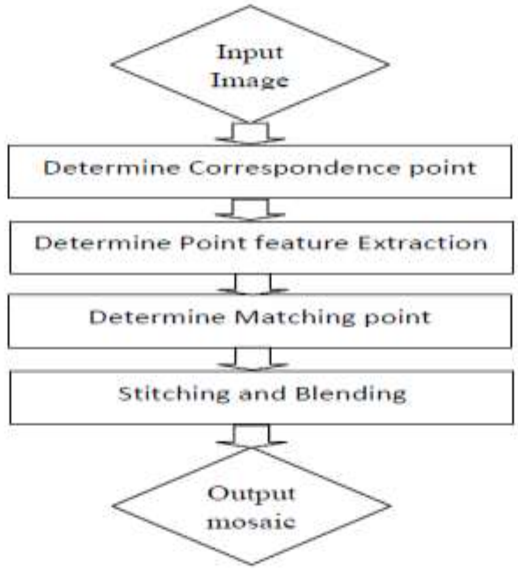

Fig. 3 Image Mosaicing Basic Method

A. Image Registration: given a set of N images I1,I2,…In} with a partial overlap between at least two images, compute an image-to-image transformation that will map each image *I2,…In*, into coordinate system of.
B. Image Warping: warp each image *I2,…In*, using the computed transformation.
C. Image Interpolation: resample the warped image.
D. Image Compositing: blend images together to create a single image on the reference coordinate system

IMAGE REGISTRATION

Image registration is the task of matching two or more images. It has been a central issue for a variety of problems in image processing such as object recognition, monitoring satellite images, matching stereo images for reconstructing depth, matching biomedical images for diagnosis, etc. Registration is also the central task of image mosaicing procedures. Carefully calibrated and prerecorded camera parameters may be used to eliminate the need for an automatic registration. User interaction also is a reliable source for manually registering images (e.g. by choosing corresponding points and employing necessary transformations on screen with visual feedback).

Automated methods for image registration used in image mosaicing literature can be categorized as follows:

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Frequency domain approaches for finding displacement and rotation/scale are computationally efficient but can be sensitive to noise. These methods also require the overlap extent to occupy a significant portion of the images (e.g. at least 50%).

Iteratively adjusting camera-motion parameters leads to local minimums unless a reliable initial estimate is provided. Initial estimates can be obtained using a coarse global search or an efficiently implemented frequency domain approach.

IMAGE COMPOSITING

Images aligned after undergoing geometric corrections most likely require further processing to eliminate remaining distortions and discontinuities. Alignment of images may be imperfect due to registration errors resulting from incompatible model assumptions, dynamic scenes, etc. Furthermore, in most cases images that need to be mosaiced are not exposed evenly due to changing lighting conditions, automatic controls of cameras, printing/scanning devices, etc. These unwanted effects can be alleviated during the compositing process. The main problem in image compositing is the problem of determining how the pixels in an overlapping area should be represented. Finding the best separation border between overlapping images has the potential to eliminate remaining geometric distortions. Such a border is likely to traverse around moving objects avoiding double exposure. The uneven exposure problem can be solved by histogram equalization, by iteratively distributing the edge effect on the border to a large area, or by a smooth blending function.

IMAGE WARPING AND BLENDING

Image Warping is the process of digitally manipulating an image such that any shapes portrayed in the image have been significantly distorted. Warping may be used for correcting image distortion as well as for creative purposes (e.g., morphing).While an image can be trans formed in various ways, pure warping means that points are mapped to points without changing the colors. This can be based mathematically on any function from part of the plane to the plane. If the function is injective the original can be reconstructed. If the function is bisection any image can be inversely transformed. 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 them known as composite panorama.

The final step is to blend the pixels 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 images overlap occurs in an output mosaic we will use the alpha values.

CONCLUSION

Image mosaicing is a powerful tool for generating larger view of a scene. Due to the wide range of applications, image mosaicing is one of the important research areas in the field of image processing. Here we have presented some of the very fundamental and basic techniques used in image mosaicing. Image mosaicing helps to capture a large document at a high resolution in single exposure. In medical imaging, mosaic images help the doctors to conduct a comprehensive and visual observation on the sourrounding parts.Document image mosaicing helps to capture a large document at a high resolution in single exposure.

REFERENCES

[1] S. C. Park, M. K. Park, and M. G. Kang, “Super-resolution image reconstruction: A technical review,” IEEE Signal Processing Mag., vol. 20, pp. 21–36, May 2003.
[2] C.D. Kuglin, D.C. hines, “The phase correlation image alignment method”, Proc IEEE 1975,pp.163-165.
[3] Yang zhan-long Guo bao-long,” IMAGE MOSAIC BASED ON SIFT”, International Conference on Intelligent Information Hiding and Multimedia Signal Processing, IEEE 2008.
[4] D.I. Barnea, H.F. Silverman, “A class of algorithms for fast digital registration”, IEEE `trans.comput., vol c-12.
[5] Corner Detection by D.Parks, J.P. Gravel.
[6] Yu Wang, Yong-tian Wang, “The image matching algorithm based on SIFI and Wavelet transform”, Journal of Beijing Institute of Technology. Vol.5, 2009.
[7] D. Ghosh, S. Park, N. Kaabouch, W. Semke, ” Quantum Evaluation Of Image Mosaicing In Multiple Scene Categories”, *IEEE Conference on Electro/Information Technology*, pp. 1-6, 2012.
[8] Azzari,P.; Stefano,L.D.; Stefano,M., Stefano,M.,” An evaluation methodology for image mosaicing algorithms” Advanced Concept for Intelligent Vision Systems,Springer,vol.5259 ,pp 89-100,2008.
[9] Wolberg, G. Digital Image Warping, IEEE Computer Society Press,pp 169-172 ,1990.
[10] Lisa G. Brown. A survey of image registration techniques. ACM Computing Surveys, 24(4) ; pp 325-376, December 1992.