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Automatic Image Mosaicing: An Approach Based on FFT

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Abstract- **In this paper, *correlation-based scheme is used which operates in the Fourier domain for* finding the transformed coordinates (translational and rotational parameters) and use them for Image Mosaicing. *In many clinical studies, it is highly desirable to acquire images as whole sections whilst retaining a microscopic resolution. A usual approach of this is to create a composite image by appropriately overlapping individual images acquired at high magnification under a microscope.* In view of this it has been calculated the translational parameters and proposed an algorithm for finding angle of rotation using Fourier Shift approach. Finally it shows merging of two images. *This algorithm can be applied to all types of light microscopy imaging.***

Keywords: **Registration, Translation, Rotation, Mosaicing, Fourier shift.**

I. INTRODUCTION

An Image mosaic is a composition generated from a sequence of images which can be obtained by understanding geometric relationships between images. The geometric relations are coordinate transformations that relate the different image coordinate systems. Image mosaic is a technique for creating images which cannot be created by a single frame of the camera, for example satellite imagery. The user gives a series of pictures with overlapping regions and the software returns one large image with all the pictures merged as accurately as possible. When it is impossible to capture the large image in one shot with available equipment, mosaicing process can be used to create an image montage from separately scanned pieces.

This paper goal is to create a script that will stitch two images together to create one larger image. These stitched images, become panoramic views which increase the visual aesthetics of a scene, and are widely sought out for posters, postcards, and other printed materials. This stitching will be performed using point correspondences between the two images.

For the class of similarity transforms, a frequency domain approach to motion estimation possesses several appealing properties. First, through the use of correlation, it enables an exhaustive search for the unknown motion parameters and, therefore, large motions can be recovered with no priority information. Second, the approach is global which equips with the algorithm and robustness to noise. Third, the method is computationally efficient. This comes from the shift property of the Fourier Transform (FT) and the use of Fast Fourier Transform (FFT) routines for the rapid computation of correlations.

The overlap-removal algorithm is based on the cross-correlation method; this is used to determine and select the best correlation point between any new image and the previous composite image. A complementary image blending algorithm, based on a gradient method, is used to eliminate sharp intensity changes at the image joins, thus gradually blending one image onto the adjacent 'composite'.

II. PROBLEM ENCOUNTERED

A. Global alignment: Global alignment involves calculation of trasform, which alingn two images
B. Local adjustment: even after good global alignment, some pixels might not align in the two images. This might cause ghosting or blur in blended images.
C. Automatic selection of images to blend from a given set of images.
D. Image blending: After one of the images has been transformed using the image homography calculated above a decision need to be made about the colour to be assigned to the overlapping regions. Blending also becomes important when there exist a moving object in the images taken.
E. Auto exposer compensation: Most cameras have an automatic exposer control. The images taken can therefore be of variable brightness in the overlapping region which might cause the mosaic to look unrealistic.

III. STEPS OF IMAGE STITCHING

1. Image calibration (perspective correction, vignette correction, chromatic aberration correction). Images are processed in this stage to improve results.
2. Image registration (analysis for translation, rotation, and focal length). Direct or feature-based image alignment methods may be used. Direct aliment methods search for image orientations that minimize the sum of absolute differences between overlapping pixels. Feature-based methods determine proper image orientations by identifying features that appear in multiple images.
3. Image blending; combining the sections

IV. IMAGE REGISTRATION

Image registration refers to the geometric alignment 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 view points .The goal of registration is to establish geometric correspondence between the images so that they may be transformed, compared and analyzed in a reference frame.

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).

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

1) 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.

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

3) 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%).

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

B. Registration Algorithm steps

To carry out this process automatically several algorithms have been proposed and they were divided into the following classes.

(1) Algorithms that directly use image pixel values
(2) Algorithms that operate in the frequency domain
(3) Algorithms that use low-level features such as edges and corners and
(4) Algorithms that use high-level features such as identified objects, or features.

In this paper we used algorithms that operate in the frequency domain
Input: Two overlapping images I1 and I2
Output: Registration parameters (tx, ty, theta) where tx and ty are translation in x and y directions respectively and theta is the rotation parameter.

1. For i=1 step: 360
   1.1) Rotate I2 by i degree .Let the rotated image be I2'rot'
   1.2) Compute the Fourier transform FI1', and FI2'rot of images I1' and I2'rot respectively.
   1.3) Let Q (u, v) be the phase correlation value of I1' and I2'rot, based on FI1' and FI2'rot.

$$\frac{FI'(u, v).\ FI'.\ rot^*(u, v)}{\left| FI'(u, v).\ FI'.\ rot^*(u, v) \right|}$$

   1.4) Complete the inverse Fourier transform q (u, v) of Q (u,v)
   1.5) Locate the peak of q (u, v).
   1.6) Store the peak values in a vector at position i.
   End for
2. Find the index of maximum peak from the value stored in the vector in step 1.6.It gives the angle of rotation. Let it be theta'.
3. Repeat steps 2.1 to 2.6 for i = theta' -step: theta' +step.
4. Find the angle of maximum peak from step
5. It becomes the angle of rotation. Let it be theta.
6. Rotate the original image I2 say, I2rot.
7. Phase correlation I1 and I2rot. Let the result be P (u, v).
8. Compute the inverse Fourier transforms p (u, v) of P (u, v).
9. Locate the position (tx, ty) which become the transformation parameter.
10. Output the parameter (tx, ty, *theta*)

The maximum peak occurs only at the point where there exists pure translation between the images.

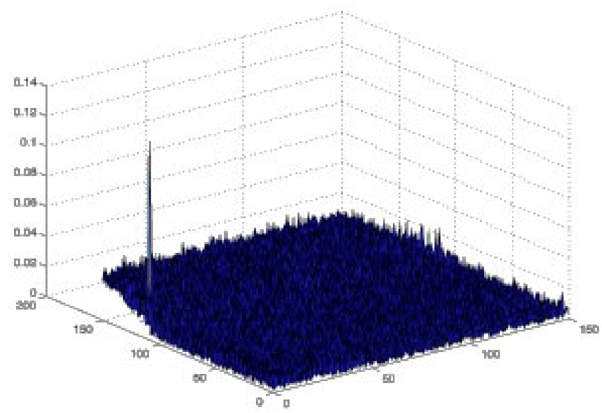

Fig 1.IFFT of cross power spectrum

C. Transformations

Suppose the two images I1 and I2 to be registered having both translation and rotation with angle of rotation being '*theta*' between them. When I2 is rotated by *theta*, there will be only translation left between the images. So by rotating I2 by one degree each time and computing the correlation peak for that angle, we reach a stage where there is only translation left between the images. That angle becomes the angle of rotation.

1. Translation Transform
   x'= x +b
2. Affine Transform
   x'=ax+b
3. Bilinear :
   x' = p1xy + p2x +p3y +p4
   y' =p5xy +p6x +p7y +p8
4. Projective Transform
   x'=(ax+b)/cx+1

V. IMAGE STICHING

Image stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panaroma or high-resolution image. Commonly performed through the use of computer software, most approaches to image stitching require nearly exact overlaps between images and identical exposures to produce seamless results. It is also known as mosaicing.

Image stitching combines a number of images taken at high resolution into a composite image. The composite image must consist of images placed at the right position and the aim is to make the edges between images invisible. The quality of stitching is therefore expressed by measuring both the correspondence between adjacent stitched images that form the composite image and the visibility of the seam between the stitched images.

Image stitching can be performed using

- image pixels directly - correlation method
- in frequency domain - fast Fourier transform method
- using low level features such as edges and corners
- using high level features such as parts of objects

VI. IMAGE BLENDING

Since the two images that are used will probably not have perfectly matching pixels at all regions where they overlap, the image blending calculations are designed to average and more properly meld the two images together. In addition, this calculation is aimed at eliminating the boundary line from one image to another.

After finding the transformation parameter for successive image pair, we have to put all of them into one big image. Easy way to put all images into one mosaic is using superimposing method. For example, initially the mosaic is empty, then the first image is put into mosaic, then the second image is being put into mosaic where mosaic has empty pixel. If any pixel in the second images is mapped to a mosaic pixel which has not been already occupied by previous image pixel, then the value of that pixel (second image) is used the value of mapped pixel in mosaic.

Once the source pixels have been mapped onto the final composite surface, we must still decide how to blend them in order to create an attractive looking panorama. Creating clean, pleasing looking panoramas involves both deciding which pixels to use and how to weight or blend them. The distinction between these two stages is a little fluid, since perpixel weighting can be thought of as a combination of selection and blending. In this section, I discuss spatially varying weighting, pixel selection (seam placement) and then more sophisticated blending.

1) Color correction: matching the adjoining areas of the component images for color, contrast and brightness to avoid visibility of the seams.

- Dynamic rang extensions.
- Motion compensation/deghosting/debluring to compensate for moving objects.

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2) Pixel averaging method

In this method, each pixel in mosaic takes its value from only one image. This method **g**ives unblured results but it has many artifacts especially corner of the overlapping area because of misalignment. In this paper, instead of superimposing method, we preferred to use pixel averaging method in blending phase.

VII. ASSUMPTIONS

The following are some of the assumptions we have made to solve the problem.

1. The input images given by the user should have at least 10% overlap for good results.
2. If the user does not get good results in the first time then user needs to try again with new points for better accuracy.
3. The brightness of the images given by the user should not differ too much.
4. The user gives the names of the images on command line in the order of the sequential order of overlapping.

VIII. APPLICATIONS

There are many applications which require high resolution images. In bright field or epifluorescence microscopy for example, which are used in biological and medical application. It is often necessary to analyze the complete tissue section which has dimensions of several tens of millimeters at high resolution. The most common approach is to acquire several images of parts of the tissue at high magnification and assemble them into a composite single image which preserves the high resolution

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. These applications have been extended towards the creation of completely navigatable “virtualized" environments by creating arbitrary views from a limited number of nodes. The reconstruction of 3D scene structure from multiple nodes has also been another active area of research.

We expect the use of image mosaicing to make a significant impact in video processing. The complete representation of static scenes resulting from mosaicing video frames in conjunction with an efficient representation for dynamic changes provides a versatile environment for visualizing, efficiently coding, accessing, analyzing information. Besides video compression and indexing this environment is shown to be useful for image stabilization and building high quality images using low-cost imaging equipments.

IX. FUTURE ASPECTS

- Till now we have worked with Mosaicing two images. We can extend it to multiple images by sending two images at a time to the algorithms proposed and merge them accordingly.
- Image panorama generation from video
- Super-resolution imaging

- Combining images to increase the resolution.
- Combining images from multiple angles to form a 3D mode

X. CONCLUSION

- A key feature of Fourier-based registration methods is the speed offered by the use of FFT routines.
- We have presented a successful method of automatically mosaicing binarised images taken with a low cost digital camera by using the phase correlation method.
- To reduce the computation time we correlated only the sub image of second image with the first image.
- The proposed algorithm has given the exact angle of rotation efficiently and the merged images are satisfactory.

Fig.1 First input image

Fig.2 Second input image

Fig.3 Mosaiced image

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