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REVIEW ARTICLE

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IMAGE MOSAICING USING PHASE CORRELATION AND FEATURE BASED APPROACH: A REVIEW

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ABSTRACT

Mosaicing is a computer-vision-based approach to attain high field of view without compromising the image quality. Image Mosaicing technique enables to combine together many small images into a single large image, which represents more information. In this paper, images with overlapping regions are mosaiced using the phase correlation and feature based approaches. Phase correlation involves featureless registration, followed by mosaicing of images, and blending of image mosaic in order to reduce seams that may arise due to different environmental conditions such as lighting, camera focusing etc. In the efficient feature based approach involves in taking scale invariant features (using SIFT) in both the images. Later to find by using the perfectly matched corner pairs, homography is done to do mosaicing. A weighted average blending algorithm is used to seamlessly blend the two images.

1. INTRODUCTION

Mosaicing is basically a technique of image processing where in tiling of digital images is done to obtain large covering in an image. Mosaicing is a research area in computer vision, to understand and interpret the information represented by the images. Image mosaicing has many applications in the fields as diverse as forensic image restoration, computer generated special effects, digital video compression and many more[1]. Information from many images can be combined into one image to aid for better understanding of what they represent. The amount of data which can be collected by the camera is small compared to the human eye. Though there exist complex lens to increase the field of view, it accounts to be costly. The other way of increasing the field of view is to capture the image from a long distance. However, very often, that is neither possible nor desirable as it may degrade the picture quality or resolution. This is where image mosaicing comes in.There are a number of methods to build image mosaics. One is to record an image onto a long filmstrip using the panorama camera. Another is to use a lens with a very large field of view, such as fish-eye lens, and a parabolic mirror. Although these methods directly capture the panoramic image, they are rather hardware intensive and expensive.

On the other hand, image mosaicing algorithm which is a less hardware-intensive and very popular to obtain a wide field of view (FOV) image of a scene. It takes many regular pictures in order to cover the whole viewing space, and then stitches together the images to construct a single image with a larger field of view. Image registration, or alignment of images, is core technique of image mosaicing; it is the process of establishing point-to-point correspondence including translations, rotation and scaling between two images of the same scene.

The Types of Image Mosaicing Techniques are can be broadly classified into direct or intensity based methods and feature based methods. Direct methods are found to be useful for mosaicing images having large overlapping regions with translations and small rotations. Feature based methods can usually handle small overlapping regions and in general tend to be more accurate.

Image mosaicing using phase correlation is one of the earliest forms of mosaicing technique. It is an intensity based mosaicing technique. This is a traditional approach, which uses correlation, suffers from computational inefficiency and is sensitive to variations in the image intensity. To improve the efficiency of image mosaics, feature-based approach is used.

2. IMAGE MOSACING TYPES:

Direct Based Method: Intensity-based methods compare intensity patterns in images via correlation metrics. It is based on the Fourier domain to match images that are translated and rotated with respect to one another. They register entire images or sub images. If sub images are registered, centers of corresponding sub images are treated as corresponding feature points.

Feature based method[6]: It is based on accurate detection of image features. Correspondences between features lead to computation of the camera motion which can be tested for alignment. Feature-based methods establish a correspondence between a number of especially distinct points in images. In the absence of distinctive features, this kind of approach is likely to fail.Image mosaicing involves the individual images to be aligned to some reference image. Any Image mosaicing algorithm consists of three basic stages:

a) Image Registration: Finding the homographies between the given images with respect to some reference image.

b)Image Stitching/Alignment: Pasting the registered images so that overlapping regions between them are merged.

c)Image Blending: Smooth out or rectify the intensity differences between the two stitched images.

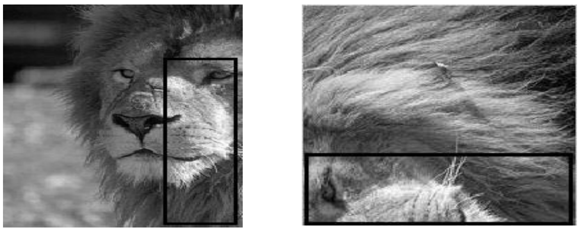
Forms of Mosaicing[6]:The most commonly used forms are planar and cylindrical mosaicing.

i)**Planar:**When it is known that the image sequences are related by a (planar) homography, all the images can be warped onto a plane and the mosaic can be constructed. For every image, the transformation required to map it to the reference plane is estimated. After the registration is done, images are blended into a seam-less mosaic.

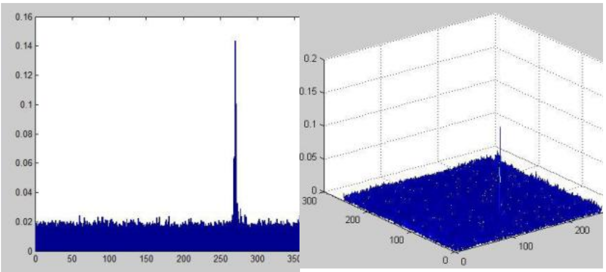
ii)**Cylindrical:**The translational motion across images is estimated in terms of cylindrical coordinates. In other words, the input images are warped onto a cylinder mapping the world point P from Cartesian coordinates [X Y Z] to 2D cylindrical coordinates (θ, r). In Spherical mosaicing, the images are mapped to a sphere rather than cylinder.

3. IMAGE MOSAICING USING PHASE CORRELATION

3.1. Image Registration: The registration method presented here uses the property of phase correlation which gives the translation and rotation parameters between two images. Suppose the two images I1 and I2 to be registered involve both translation and rotation with an angle of rotation being θ' between them. When I2 is rotated by θ, there will be only translation left between the images and the phase correlation with I1 should give maximum peak. 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, which are characterized by the highest peak for the phase correlation. That angle becomes the angle of rotation .If there is no other transformation between the images other than translation, this shows a distinct peak at the point of the displacement. With this as the basis, translation is also found.Output: Registration parameters (tx, ty, θ) where tx and ty are translation in x and y directions respectively and θ is the rotation parameter.



(a) Input image1 (b)Input image 2



© Peak values of Phase correlation (d)Phase correlation plot after rotating image 2

Figure 1: Phase correlation method to find rotation and translation parameters.[4]

3.2. Image Stitching:Image stitching is the next step following the registration. At this stage, the reference image is overlaid on the source image by pasting its pixels on a canvas at the appropriate location using the transformation parameters obtained in the registration process.

3.3 Image Blending: The last step in mosaicing is Image Blending, which modifies the image gray levels in the vicinity of common boundary to obtain a smooth transition between images by removing the seams. Creating a blended image requires determining how pixels in an overlapping area should be presented. The advantage of Phase correlation technique is that it can be applied to best only for images having large overlap region with translation and smaller rotations.

4. FEATURE BASED IMAGE MOSAICING

In practice, the images generally have certain homographic transformation between them which cannot be solved using the phase correlation technique. Therefore, feature based method is used for mosaicing the images having homography between them.

Concerning the purposes of image mosaicing, feature based methods aim to determine a relationship between the images through distinct features extracted from the images. Compared to direct methods which utilize comparisons of all the pixel intensities in each image while determining such a relationship, one large advantage of feature based methods is a major reduction in computational complexity. An additional, though not so decisive, advantage for feature based methods over direct methods is that nearly all feature based mosaicing systems have the property of strong structural similarity. The processing involved with feature based mosaicing systems can generally be broken down into five distinct stages. At each stage different algorithms can be implemented to compute results and then be used by thenext stage of mosaicing process. This is demonstrated in Figure 2

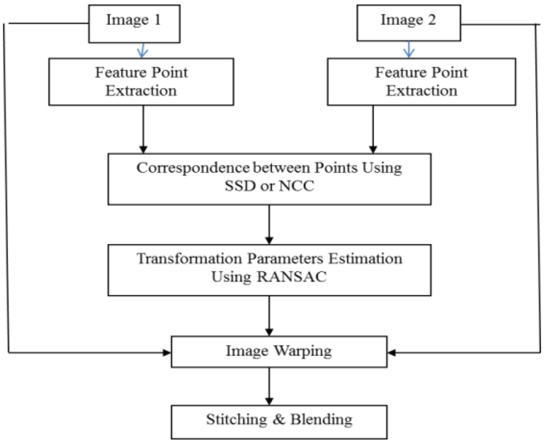


Figure 2: Stages in feature based mosaicing

4.1 ***Feature extraction:***Features are extracted in this stage for each image contributing to the formation of the mosaic. Various types of features can be extracted from an image. However, feature types and algorithms used in mosaicing include classical Harris corners and the scale-invariant feature transform (SIFT)[10]. The feature vectors themselves are used in 2nd stagematching, and detected image locations of the features is used in the computation of a homography in 4th stage as shown in Fig4.

4.2 ***Feature Matching***: In the second stage of processing, features are matched between each pair of overlapping images. These matches should be as accurate as possible, yet it is nearly impossible for a single algorithm in this stage to compute only the correct matches. For this reason, this processing stage produces putative feature correspondences. A good proportion of these correspondences should be correct, but need not be perfect matching, since RANSAC will later be used to eliminate the mismatches. These are used as seed correspondences. These putative correspondences are obtained matching the corner points using a combination of proximity and similarity of intensity neighbourhoods. There are two different methods to find the correspondences, first is using sum of squared differences (SSD) and the second is using normalized cross correlation (NCC).

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

$$NCC(i,j) = \frac{\sum w\,(I(X) - I_1)(I_2(X') - I_2)}{\sqrt{\sum w\,(x_i)(I(X) - I_1)^2 \sum w(x_j')(I_2(X') - I_2)^2}}$$

4.3***Elimination of Outliers***: In the third stage of mosaicing for feature based systems, false matches are detected through an estimation process. This estimation process fits feature matches to a probabilistic model. The parameters of the model which best accommodate the feature set are then selected which in the case of mosaicing are the elements of a homography matrix.

4.4***Estimation of Homography Using RANSAC[(Robust Homography Estimation for a Pair of Images):***In this stage, the final mapping is computed which will relate coordinates of two overlapping images captured of a common scene. The input to this stage is estimated feature match inliers between two images. A homography is the name of a matrix capable of projectively mapping points in one image to those in another.

The main advantage of RANSAC [11] is its low cardinality when compared to that of other estimation models like Least squares where the parameters are estimated using all the data available. Cardinality gives the minimum number of data points required to determine the model parameters.

After we get n putative correspondences, the RANSAC robust estimation is used in computing 2D homography. Estimate H from all the inliers using the Direct Linear Transform(DLT) algorithm[4].

4.5***Perspective image transformation (Image Stitching):***To complete the process of mosaicing computed homographies are used to transform the set of individual images captured of a common scene, projecting them as one, final complete image. This single image containing all of the imaged portions of a single scene is called the mosaic, and this stage of processing is called perspective projection.

4.6***Blending:***As a part of image mosaicing, separately recorded photographs are aligned and combined to cover the entire desired region. Since the parts may have been recorded under different conditions, including weather, lighting, film processing and noise, they may have different gray level characteristics. This may cause seems to be apparent between different parts. Therefore, blending techniques are employed as the "final stage" to eliminate the natural seams that appear at the region of transition requirements is to use this document as a template and simply type your text into it.

5.EXPERIMENTAL RESULTS

5.1 **Results of Phase correlation:** Phase correlation results are shown below on input images shown in figure (a) and (b).

5.2 **Results for Feature Based Image Mosaicing:**Here for each pair of images that are to be mosaiced, initial input images , images with corners, image depicting the putative correspondences, image indicating the matching of the inliers obtained from RANSAC, warped image and the final mosaiced image are presented along with the estimated homography (H).Fig 4 and Fig 5 shows thedifferent stages in the mosaicing of Atlas map image and Lab images respectively.

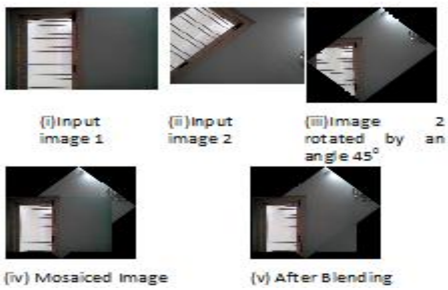


Figure 3: Results of Phase Correlation based mosaicking

Table1: Estimated H for each of the example images

Sl no.	Image Name	Estimated H
1	Map	$\begin{bmatrix} -0.0179 & 1.119 & 10.437 \\ -1.1333 & 0.0211 & 814.93 \\ 0.0000 & -0.0000 & 1 \end{bmatrix}$
2	Lab	$\begin{bmatrix} 0.0024 & -0.0001 & -0.9493 \\ 0.0005 & 0.0021 & -0.3144 \\ 0.0000 & -0.0000 & 0.0015 \end{bmatrix}$

6. CONCULSION

In this paper, we have used simple blending algorithms like averaging and weighted averaging which do not completely satisfy the purpose of blending. Therefore, advanced blending algorithms like pyramidal blending can be used for better blending. Algorithms can be improved for mosaicing images taken by moving the camera in cylindrical fashion. The same algorithm can also be extended for multiple input images to obtain the larger field of view.

In this project two different approaches of mosaicing are presented, namely Phase correlation and feature based image mosaicing. These techniques help in achieving a larger field of view using the cameras with the normal view

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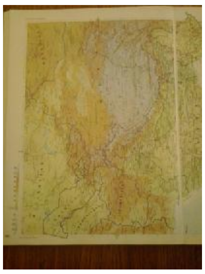
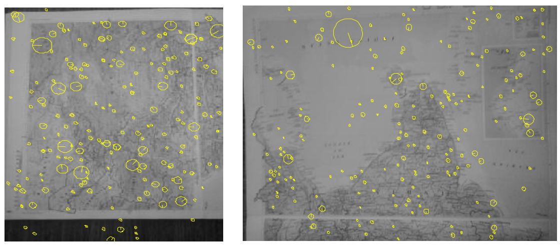
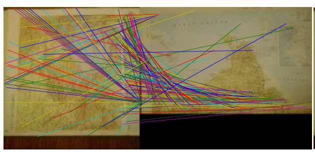


(a)Input image 1

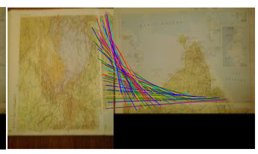
(b) Input image 2



(c)SIFT features of input images



(e) 142 Putative matches



(f) Inlier matches (64 matches are inliers out of 70)

(g) Warped image 1 (h) Warped image 2 (i) Mosaiced Image

Fig: 4 Mosaicingprocess of Altas Map Images

(a) Input image 1 (b) Input image 2 (c) SIFT features of image (d) SIFT features of image 2

(e) 142 Putative matches (f) Inlier matches (64 matches are inliers out of 70)

Fig: 5Mosaicing process of Lab Images

(g) Warped image 1 h) Warped image 2 (i)Mosaiced Image

Fig 5.Mosaicing process of Lab Image