Image Mosaicing Using Feature Detection Algorithm

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Abstract
An image mosaicing is a method of assembling multiple overlapping images of the same scene into larger image. It is the process that integrates two or more small images into large-size image with wide field of view. Union of the two input images will be the output of the image mosaic. The input images are stitched using various feature detection algorithms like Harris algorithm, SIFT algorithm. These are corner detection algorithms. There are steps used in image mosaicing i.e. feature extraction, image registration, computing homography using RANSAC algorithm and image transform using image warping and blending. Feature detection algorithms give good results for image mosaicing.

Keywords: Image Mosaic, Image Registration, Feature Detection, Sift Algorithm, RANSAC Algorithm.

1. Introduction
Image mosaicing is a stiching of multiple correlated images to generate a larger wide-angle image of a scene. In image mosaicing two input images are taken and these images are fused to form a single large image this merged image is the output mosaiced image. Image mosaicing is being done such that images taken by normal camera can be used to create a larger field of view using a image mosaicing program. The program is basically a tools which help you to find out the corresponding camera angles that you used to take the image. The result image can also be used for texture mapping of a 3D environment scene with real images.

There are five steps in image mosaicing process. The first step is image extraction. In image extraction, features are detected in both the input images. The next step is image registration. It is the task of matching two or more images. Registration methods can be divided into the following classes: algorithms that use image pixel values directly, algorithm that use the frequency domain, algorithms that use low level features such as edges and corners and algorithms that use high-level features. The next step is computing homography using RANSAC algorithm. In this undesired corners which do not
belong to overlapping area are removed. The last steps are 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 destroyed. Image blending is the final step which blends the pixels colors in the overlapped region to avoid seams. Image mosaicing has wide applications in the field of 3D image reconstruction, medical image analysis, space exploration and many other fields. In this paper we have given feature detection algorithm which is used in image mosaicing. Feature detection is a low-level image processing operation. That is, it is usually performed as the first operation on an image, and examines every pixel to see if there is feature present at that pixel. If this is a part of a larger algorithm, then the algorithm will typically only examine the image in the region of features.

2. Feature Extraction

Feature extraction is the first step in image mosaicing. Once features have been detected, a local image patch around the feature can be extracted, this extraction may involve quite considerable amounts of image processing. The result is known as a feature descriptor or feature vector. Transforming the input data into the set of features is called feature extraction. Features are the elements in the input images to be matched like edges, corners, blobs, ridges. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to get mosaic image i.e. output. The features are detected using various algorithms like Harris corner detection algorithm, SIFT (Scale Invariant Feature Transform) algorithm, FAST algorithm and SURF (Speeded up robust feature). In this we see the SIFT algorithm.

A. SIFT algorithm

Scale-invariant feature transform or (SIFT) is an algorithm in computer vision to detect and describe local features in images. The algorithm was published by David Lowe in 1999. SIFT can robustly identify objects even among clutter and partial occlusion as it is invariant to uniform scaling, orientation and partially invariant to affine distortion and illumination changes. The components of the SIFT algorithm for key point detection are as follows:

I. Scale-space extrema detection: a set of octaves are generated using a cascade filtering approach and each octave contains difference-of-Gaussian images covering the range of scales. Local maxima and minima are then detected over all scales and image locations. This forms a set of candidate key points.

II. Keypoint localization: to determine location and scale, each candidate keypoint is fit to a detailed model. The points with low contrast and poorly localized edge points are rejected.

III. Orientation assignment: each keypoint is assigned a direction based on local image gradient. Additional keypoints are created in case of more strong directions.

IV. Key point descriptor: this is achieved by sampling image gradient magnitudes and orientations around each key point and putting those in an array of orientation histograms covering the region around the key point. Gradients are at the scale of the key point and all orientation are relative to key point direction providing rotation invariance. To reduce the effect of illumination changes, the entries of all histograms are then put in a descriptor vector which is also normalized.

For image matching, descriptor vectors of all key points are stored in a database and matches between key points are found based on Euclidean distance.
3. 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. Image registration is the important step in image mosaicing. Automated methods for image registration used in image mosaicing 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 tested for alignment.
- Exhaustively searching for a best match for all possible motion parameters can be computationally extremely expensive.
- Frequency domain approaches for finding displacement and rotation/scale are computationally efficient but can be sensitive to noise.
- Iteratively adjusting camera-motion parameters leads to local minimums unless a reliable initial estimate is provided.

4. Homography

A. RANSAC Algorithm

Homography is the third step in the image mosaicing. In this step, undesired corners which do not belong to overlapping regions are removed using RANSAC algorithm. RANSAC stands for RANdom Sample Consensus (RANSAC). It is proposed by Fischler and Bolles. It is a general parameter estimation approach designed to cope with a large proportion of outliers in the input data. RANSAC is a resampling technique that generates candidate solutions by using minimum number observations (data points) required to estimate the underlying model parameters. RANSAC uses the smallest set possible and proceeds to enlarge this set with consistent points. The basic algorithm is given as follows:

I. Select randomly the minimum number of points required to determine the model parameter,
II. Solve the parameters of model.
III. Determine how many points from the set of all points fit with a predefined tolerance.
IV. If the fraction of the number of inliers over the total number points in the set exceeds a predefined threshold, re-estimate the model parameters using all the identified inliers and terminate.
V. Otherwise, repeat steps 1 through 4. (Maximum of N times).

The number of iterations N, is chosen high enough to ensure that the probability p that at least one of the sets of random samples does not include an outlier.

5. Image Warping And Blending

This is the final step in image mosaicing. Image warping is the process of digitally manipulating an image such that any shapes portrayed in the image have been distorted. Image warping is used for correcting image distortion as well as for creative purposes. To avoid seams image blending is
done. When different images are stitched together, for various reasons the adjacent pixels intensities differ enough to produce artifacts. To remove artifacts, there are algorithms like 1. Feathering and 2. Image pyramids.

In the feathering image blending, the pixel values in the blended regions are weighted average from the two overlapping images. In the pyramid blending, laplacian pyramid is an algorithm using Gaussian to blend the image while keeping the significant feature in the mean time.

Following examples shows the image mosaicing process. These are the two input images shown below:

![Figure 1: Input images](image1.jpg)

Now we extract the features from both the input images.

![Figure 2: Extract features](image2.jpg)

In the following figures, after extracting the features we match the images and computed the homography using RANSAC.

![Figure 3: Match and filter using RANSAC](image3.jpg)

And at last we transform the images and image blending is done so that we get output image that is mosaic image.
6. Conclusion

In this paper, we have given that how image mosaicing is done using feature detection algorithm like SIFT. Feature detection algorithms are very useful in the field of image mosaics. The steps involved in this process are useful to give a mosaic image. The image obtained using SIFT algorithm is scale invariant and very effective and robust.

7. References


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