A Survey and Review Over Image Alignment and Stitching Methods

K.Shashank, N.SivaChaitanya, G.Manikanta, Ch.N.V.Balaji, V.V.S.Murthy
Dept. of ECE, Signal Processing Research Group, KL University, Vaddeswaram, Guntur, AP, India

Abstract
Image stitching or photo stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama 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. Some digital cameras can stitch their photos internally. The image mosaicing is one of the most widely used techniques for semi-automated or automated recovery of original documents from ripped up documents. Reconstruction of hand torn paper documents is a challenging task in forensic and investigation sciences. There are a number of hard and soft constraints that must be observed while stitching images. It is an active research area in the fields of photogrammetric, computer vision, and computer graphics. In this paper, several approaches have been dealt to overcome image stitching problem which are summarized briefly.

Keywords
Image Mosaicking, Image Reconstruction, Image Alignment, Stitching Method

I. Introduction
The image stitching process can be divided into three main components - image registration, calibration and blending. Image registration involves matching features in a set of images or using direct alignment methods to search for image alignments that minimize the sum of absolute differences between overlapping pixels. When using direct alignment methods one might first calibrate one’s images to get better results. Additionally, users may input a rough model of the panorama to help the feature matching stage, so that - for example - only neighboring images are searched for matching features. Since there are smaller group of features for matching, the result of the search is more accurate and execution of the comparison is faster. Image calibration aims to minimize differences between an ideal lens models and the camera-lens combination that was used, optical defects such as distortions, exposure differences between images. If feature detection methods were used to register images and absolute positions of the features were recorded and saved, stitching software may use the data for geometric optimization of the images in addition to placing the images on the panoramphere. Panotools and its various derivative programs use this method. Image blending involves executing the adjustments figured out in the calibration stage, combined with remapping of the images to an output projection. Colors are adjusted between images to compensate for exposure differences. If applicable, high dynamic range merging is done along with motion compensation and deghosting. Images are blended together and seam line adjustment is done to minimize the visibility of seams between images.

II. Stitching Technique for Scenes With Large Motions and Exposure Differences
Ashley Eden et al presents a technique to automatically stitch multiple images at varying orientations and exposures to create a composite panorama that preserves the angular extent and dynamic range of the inputs. The proposed method allows for large exposure differences, large scene motion or other misregistrations between frames and requires no extra camera hardware. To do this, they introduced a two-step graph cut approach. The purpose of the first step is to fix the positions of moving objects in the scene. In the second step, they fill in the entire available dynamic range.

III. Haar Wavelet 2D Integration Method
Ioana S. Sevcenco et al presented a method for seamless stitching of images with photometric inconsistencies in the overlapping region. Two main approaches to gradient domain image mosaicking are the Gradient-domain Image Stitching algorithm, and the optimal seam techniques. Gradient-domain Image Stitching, blends the gradients of the source images in the overlap region and the image is then reconstructed from this gradient data set by an FFT based technique. For two given registered images, optimal seam techniques search the overlap regions for a curve along which the difference between the images is minimum. The method proposed
by Ioana et al is based on generating a set of stitched gradients from the gradients of the input images and then reconstructing the mosaic image using the Haar wavelet integration technique. A set of gradients for the mosaic image generated by blending the gradients of the source images in the overlap region and pasting the gradients from the source images in the rest. The image mosaic will be reconstructed from this gradient data set. The image reconstruction from the gradient will be done here based on the Haar wavelet decomposition. The basic idea is that the Haar wavelet decomposition of the resulting image can be directly computed from the gradient data and the image can then be recovered from this decomposition using Haar synthesis.

IV. Seamless Image Stitching in the Gradient Domain

The quality of image stitching is measured by the similarity of the stitched image to each of the input images, and by the visibility of the seam between the stitched images. In order to define and get the best possible stitching, Anat Levin et al introduce several formal cost functions for the evaluation of the quality of stitching. In these cost functions, the similarity to the input images and the visibility of the seam are defined in the gradient domain, minimizing the disturbing edges along the seam. A good image stitching will optimize these cost functions, overcoming both photometric inconsistencies and geometric misalignments between the stitched images. This approach is demonstrated in various applications, including generation of panoramic images, object blending, and removal of compression artifacts.

The aim of a stitching algorithm is to produce a visually plausible mosaic with two desirable properties: First, the mosaic should be as similar as possible to the input images, both geometrically and photometrically. Second, the seam between the stitched images should be invisible. While these requirements are widely acceptable for visual examination of a stitching result, their definition as quality criteria was either limited or implicit in previous approaches. Authors presented several cost functions for these requirements, and define the mosaic image as their optimum. The stitching quality in the seam region is measured in the gradient domain. The mosaic image should contain a minimal amount of seam artifacts, i.e. a seam should not introduce a new edge that does not appear in either 11 or 12. As image dissimilarity, the gradients of the mosaic image I are compared with the gradients of I1; I2. This reduces the effects caused by global inconsistencies between the stitched images. Framework named by them as GIST: Gradient-domain Image Stitching. They demonstrated that approach in several applications, including panoramic mosaicing, object blending and removal of compression artifacts. Analytical and experimental comparisons of their approach to existing methods show the benefits in working in the gradient domain, and in directly minimizing gradient artifacts.

V. Image Stitching Using Watersheds & Graph Cuts

Creating panoramas or high resolution images is one common application of image stitching. To create seamless images is often very computationally demanding. On the other hand, the technological evolution of the latest years has created a customer demand for these algorithms to be used in handheld devices, such as cameras and cell phones. The methods need therefore to be faster in order to work in near-real-time on mobile devices. Using one of the simpler algorithms often results in degrading artifacts, such as artificial seams or blurred regions. To favor seamless blending and clarity in the blending areas, while keeping a low computational cost, is the main motivation of the work presented by Patrik Nyman. The implementation of a fast image blending algorithm, based on the watershed algorithm and graph cuts, is presented by him. The images are first aligned using SURF-matches.

VI. Efficient Stitching in the Presence of Dynamic Objects and Structure Misalignment

Chao Tao et al, presented a new method for simultaneously eliminating visual artifacts caused by moving objects and structure misalignment in image stitching. Given that the input images are roughly aligned, they implemented mechanism in two stages. In the first stage, they discover motions between input images, and then extract their corresponding regions through a multi-seed based region growing algorithm. In the second stage, with prior information provided by the extracted regions, they performed a graph cut optimization in gradient-domain to determine which pixels to use from each image to achieve seamless stitching. There are three problems which often occur in the field of image stitching, namely exposure difference, structure misalignment and ghosting artifacts. Authors suggested solutions to two problems, one is ghosting effect caused by moving objects within a scene, and the other is structure misalignment in the overlapped region, which is usually due to inaccuracy of registration methods, motion parallax and etc. They considered the basic case of stitching two roughly aligned images. Their proposed algorithm is implemented in two stages. In the first stage, they discover the motions between two input images, and then extract their corresponding regions. With prior information provided by the extracted regions, the second stage is to find an optimal seam, which can simultaneously eliminate visual artifacts caused by the moving objects and structure misalignment. They formulated the task as a labeling problem, and solve it by graph cut.

VII. Seamless Image Stitching by Minimizing False Edges

Various applications such as mosaicing and object insertion require stitching of image parts. The stitching quality is measured visually by the similarity of the stitched image to each of the input images, and by the visibility of the seam between the stitched images. In order to define and get the best possible stitching, several formal cost functions for the evaluation of the stitching quality are introduced in this paper. In these cost functions the similarity to the input images and the visibility of the seam are defined in the gradient domain, minimizing the disturbing edges along the seam. A good image stitching will optimize these cost functions, overcoming both photometric inconsistencies and geometric misalignments between the stitched images. Assaf Zomet et al studied the cost functions and compare their performance for different scenarios both theoretically and practically. Their approach is demonstrated in various applications including generation of panoramic images, object blending and removal of compression artifacts. Comparisons with existing methods show the benefits of optimizing the measures in the gradient domain.

VIII. Automatic Seamless of Image Stitching

Russol Abdelfatah et al presented a technique to implement image stitching by adopting feature-based alignment algorithm and blending algorithm to produce a high quality image, the images for stitching to create panorama are captured in a fixed linear spatial interval. The processing method involves feature extraction, image matching based on Harris corner detectors.
method as the feature detection and neighbouring pairs alignment using RANSAC (RANdom Sample Consensus) algorithm. Linear blending is applied to remove the transition between the aligned images. They presented a image stitching algorithm, which is successfully able to create panorama image.

IX. Conclusion

After studying a number of papers related to image stitching methods, we concluded that Image registration and image blending are its two major components. Image registration aims at finding the geometric relationship between the to be mosaicked images, while the image blending is concerned with creating a seamless composition. In mosaicing, as the matching is done between two fragments, usually occurs over only a fraction of their corresponding contours, partial curve matching is must.

References


V.V.S.Murthy received his B.E. degree in ECE from Sir C.R.R.Engineering college, Eluru, in 2002, and the M.Tech. degree from JNTUH, in 2006. He is pursuing his Ph.D. from Acharya Nagarjuna University. Currently he is working as Associate Professor in ECE department of K.L.University. His research interests include Applications of signal processing and non destructive testing of objects. He is a member of Signal Processing Research Group, ECE department, K.L.University.

K.Shashank, N.Siva Chaitanya, G.Manikanta, Ch.N.V.Balaji are the student members of Signal Processing Research Group, ECE department of K.L.University.