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A Brief Review on Image Stitching and Panorama Creation Methods

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Abstract: Image stitching (Mosaicing) is regarded as an effective research place with laptop or computer perspective along with laptop or computer design. Image stitching is associated with merging 2 or more images from the exact same landscape into just one high resolution image which is sometimes called beautiful image. Image stitching is the practice during which distinct photographic images usually are integrated in order to create a new image with high resolution. The majority of image stitching approaches demand particular overlap in between image and exposures are there to give greater result. Image stitching is traditionally used technique for recovering original files from ripped files. It is also utilized in forensic science for the reconstruction involving torn paper, that's a massive problem. Inside image mapping, stitching is performed to accomplish the total mapping involving certain areas. This paper discusses about the image stitching techniques along with their comparison.

Keywords: SIFT, SURF, PCA-SIFT, RANSAC, Stitching.

1. INTRODUCTION

Image mosaicing is the procedure for merging a number of photos along with overlapping areas to produce a segmented panorama or high-resolution image. Most frequent techniques of image stitching demand exposure overlaps on particular image to produce smooth final results.

Picture stitching is the way toward joining numerous photographic pictures with covering fields of view to create a sectioned display or high-determined picture. Normally performed using PC programming, most ways to deal with picture sewing require almost correct covers amongst pictures and indistinguishable exposures to deliver consistent results, [1][2] albeit some sewing calculations really advantage from diversely uncovered pictures by doing HDR (High Dynamic Range) imaging in districts of cover.

With the advancement in technology, many digital cameras/phones can stitch their images internally along with different techniques like image stitching with a computer along with computer graphics software [8]. Thus, wide ranging image mosaicing operates by having a lot of images through a normal diagram and stitching them with each other in order to create some sort of composite image having a larger subject involving view [10].

The grade of image stitching is actually scored because of the similarity of the sewed image to be able to all the input photos. Furthermore, it might be scored because of the awareness of the seam relating to the sewed photos [9].

Image stitches procedure is usually broken down in to three steps- picture enlistment, picture calibration, and blending [6]. First of all, preprocessing is done which improves the quality of images in order to generate high dynamic range pictures. In such cases image enhancement methods are used to improve the contrast and enhance the edges and corners [3]. Picture enlistment is a coordinating element in a gathering of pictures. Furthermore, it utilizes coordinate picture arrangement strategy for picture arrangements which minimizes the entirety of outright contrasts between covering pixels [12]. In direct arrangement technique, the picture is adjusted to get great outcomes. Likewise clients can include just essential points of interest of scene for better coordinating stages. For example, just neighboring pixels are looked for better coordinating element. As there is little gathering of elements that are accessible for coordinating reason, so the looked result is more precise and the execution is likewise quicker. Varieties in power are likewise present notwithstanding, when two pictures are splendidly enrolled. Keeping in mind the end goal to lessen these varieties and enhances visual quality, a mixing calculation is utilized. While in alignment some noise get added in the overlapping area, so to deal with this problem some advance methods are introduced which define upto which content images should be overlapped so as to reduce the effect of noise [4].

Picture calibration is utilized to minimize the distinctions that happen between a perfect focal point model and camera focal point demonstration that was utilized. Likewise some optical imperfections like twisting, introduced contrasts were lessened through calibration [5]. In the event, component recognition techniques were utilized to enroll pictures and supreme places of the elements were recorded and spared, sewing programming may utilize the information for geometric streamlining of the pictures notwithstanding setting the pictures on the panosphere. Adjustment is utilized to align the pixels that will be sewed. Picture mixing executes the conformities that were recognized in the alignment arrange& joined with remapping of the pictures to a yield projection. In the middle of pictures, hues are likewise balanced with the remuneration of presentation contrasts and for pay of deghosting and movement pictures, high element extends combining are finished. Pictures are mixed together and crease line alteration is done to minimize the perceivability of creases between pictures. Crease alteration is done through pick up modification technique. This remuneration is utilized to minimize the power contrast of covering pixels. Picture mixing calculation dispenses more weight to pixels close to the focal point of the picture. Fixing is another technique to redress the picture.

Image enrollment is a corresponding attribute within a gaggle of pictures and as well this utilizes primary picture conjunction opportunity for browsing picture alignments which in turn reduces the sum complete variations between overlapping pixels [7]. In primary conjunction procedure, the actual picture is actually calibrated to have accomplishment. In addition consumers are able to feedback solely essential information on panorama intended for better corresponding levels. For instance, solely neighboring pixels are generally looked for better corresponding attribute. Because you will find small number of functions are for sale to corresponding function, to ensure the researched result is actually much more appropriate plus the performance is additionally more quickly. Variants within depth are also present even though a couple pictures are generally completely authorized. To be able to decrease these kinds of different versions and also helps image excellent, a blending together protocol is utilized.

Figures 1 and 2 shows the result of splining two photos, an apple accompanied to anorange. The mosaic attained without a spline is shown with Figure 2.

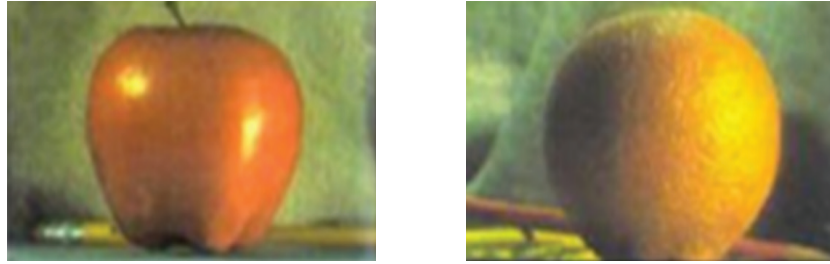


Figure 1: Initial images-Apple image (a) Orange image (b)

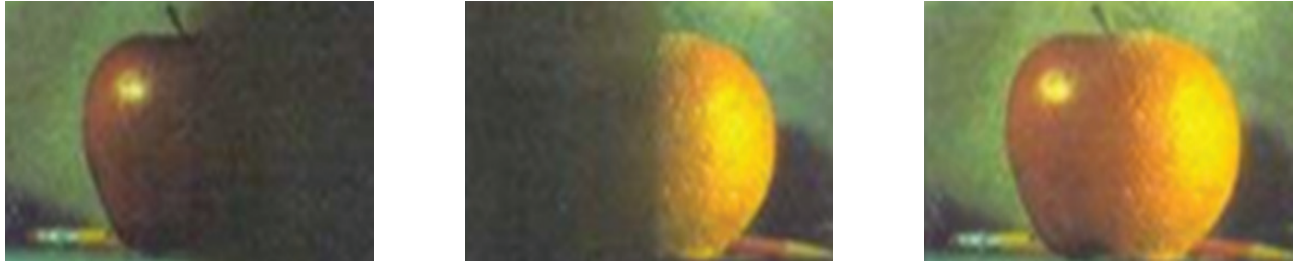


Figure 2: Output of the Blending System

2. FEATURES USED FOR IMAGE PANORAMA

Harris Corner Detection

Harris Corners are nothing but the interest areas located in the image of interest with high variations in intensity of pixel data in every direction. The below given formula finds the change in pixel intensity for a displacement factor (u, v) in whole image. This is expressed as below:

$$E(u, v) = \sum_{x, y} w(x, y) |I(x + u, y + v) - I(x, y)| \quad (1)$$

Harris function is either a rectangular kernel or Gaussian in nature, which gives weights to pixels underneath. The function $E(u, v)$ is to be increased for Harris corner detection [9].

Affine invariance

It can be defined as scale invariance transform for non-isotropic scale change, change by different factors in different directions is made. The viewing angle is also considered. The transformation is handled utilizing specific Gaussian kernel, for extracting scale space representation of the image. It is defined by

$$G(x, \Sigma) = (1/\sqrt{2\pi \det \Sigma}) \times \exp -x^T \Sigma^{-1} x \quad (2)$$

where, Σ is defined as transformation of the image. Using modified kernel, the affine-space approach [9].

Difference of Gaussians Detector (DOG)

DOG detector is based on the scale, luma and orientation factors. The DOG (I, x, σ) is defined as:

$$\text{DOG}(I, x, \sigma) = (G(x, k\sigma) - G(x, \sigma)) \times I = L(x, k\sigma) - L(x, \sigma) \quad (3)$$

DOG computes from two Gaussian of an image, with difference by a factor k used for smoothing, allowing an image pyramid with sampling between each octave of the image. DOG operator also locates points at high variation scales, resulting in stable characterizing of image features.

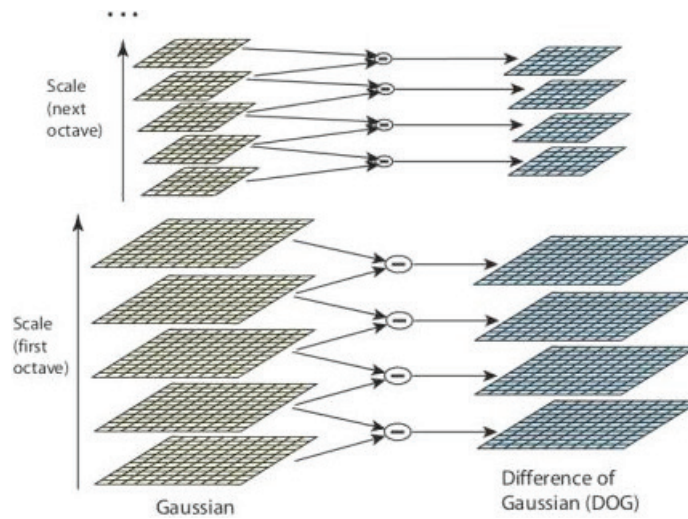


Figure 3: DOG scale-space computation

The detector is based on octave and pyramid based re-sampling scale-space formulation between octaves. The detection of POI using the DOG can be summarized as maxima and minima of DOG, observed by each pixel in the pyramid to its 26 neighbors, the neighborhood of the point in scale space. The non-eliminated points are the local max/min and result in local interest points, which enable to associate specific scale character to each point, in this way achieving high scale invariance for image [9].

Local Symmetry Features

It is measured across symmetry axes of an image, by mapping the pixels bilaterally using a reference origin. This gives rise to low symmetry distance, which is removed by convolving with LoG kernel [13]. This converts the symmetry distance SD into symmetry score function, given by

$$SS = LoG \times SD \tag{4}$$

where, LoG is Laplacian of Gaussian and SD is the Symmetry Distance of local features.

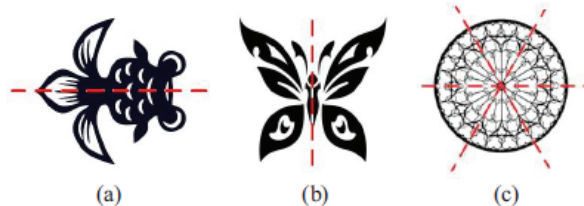


Figure 4: Shows (horizontal symmetry Middle: vertical symmetry. Right: rotational symmetry)

Color Feature Extraction

Color Image is composed of 3 gray layers where each layer corresponds to the RGB channels with $N \times N \times 3$ dimension with each layer having range of 0-255 combinations.

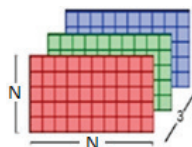


Figure 5: RGB Image representation

The color features are computed using various filters and stored in the database for further processing.

Mean Color Information: Extracts the overall color mean distribution in an image given by:

$$\begin{aligned} \text{mean_r} &= \text{mean2}(\text{Red}); \\ \text{mean_g} &= \text{mean2}(\text{Green}); \\ \text{mean_b} &= \text{mean2}(\text{Blue}); \end{aligned}$$

Median Derivative Information: Extracts the overall color median distribution in an image for centering a fixed value and is given by:

$$\begin{aligned} \text{median_r} &= \text{median}((\text{median}(\text{Red}))'); \\ \text{median_g} &= \text{median}((\text{median}(\text{Green}))'); \\ \text{median_b} &= \text{median}((\text{median}(\text{Blue}))'); \end{aligned}$$

Standard Deviation Information: Used for finding the change in color or color deviation for RGB layers in an image. Also used for finding the vibrancy and is given by:

$$\begin{aligned} \text{std_r} &= \text{std}((\text{std}(\text{Red}, 0, 1))', 0, 1); \\ \text{std_g} &= \text{std}((\text{std}(\text{Green}, 0, 1))', 0, 1); \\ \text{std_b} &= \text{std}((\text{std}(\text{Blue}, 0, 1))', 0, 1); \end{aligned}$$

Pixel Distance Measure

In our test, we choose D8 distance (also called chessboard distance) as the distance measure:

$$D_8(p, q) = \max(|p_x - q_x|, |p_y - q_y|) \quad (5)$$

That's the maximum of the distance in x direction and y direction. It's easy to compute and proved to be effective [9].

Features Distance Measure

The absolute distances are same for both cases, but it's obviously that the difference in the second case is more significant [9]. So we use the relative measure of distance:

$$d_{(r,s)} = \frac{r-s}{1+r+s} \quad (6)$$

The 1 in the denominator is added to prevent division by zero. For the feature of histogram:

$$|I - I'|_h \equiv \sum_{i \in [m]} \frac{|h_{C_i}(I) - h_{C_i}(I')|}{1 + h_{C_i}(I) + h_{C_i}(I')} \quad (7)$$

For the feature of auto-correlogram:

$$|I - I'|_\gamma \equiv \sum_{i \in [m], k \in [d]} \frac{|\gamma_{C_i}^{(k)}(I) - \gamma_{C_i}^{(k)}(I')|}{1 + \gamma_{C_i}^{(k)}(I) + \gamma_{C_i}^{(k)}(I')} \quad (8)$$

Image switching is the technique of merging different images into one frame work. Concept of image switching can be performed by two different techniques.

Image panorama techniques are classified in to two categories [1].

- Direct techniques
- Feature-based techniques

Direct Techniques

In direct technique, each pixel intensity is contrasted with every other pixel intensity. The primary favorable position of direct technique is that it minimizes the aggregate of supreme contrasts between covering pixels. In this system, each & every pixels are contrasted, so it's an extremely complex method. They are invariant to picture scale and revolution. Coordinate technique ideally utilize the data assembled from the picture arrangement. It gauges the commitment of each pixel in the picture. The primary burden of direct procedures is that they have a restricted scope of union. Coordinate Method utilizes data from all pixels. It iteratively redesigns a gauge of homography, so that cost capacity is minimized. Phase-Correlation is utilized to assess a couple of parameters of the homography.

Though in every method, all single pixel intensities connected with picture are generally as opposed with each other. The benefit of one on one method is usually it minimizes some utter distinctions among overlapping pixels. In this method, every single pixel is generally opposed with each other consequently which is an incredibly complex method. They may definitely be not invariant to picture level and also to rotation. Direct technique optimally utilized the info accumulated on the picture alignment. The item steps the factor of the pixel inside picture. The key disadvantage connected with one on one tactics is usually that they have a finite array of convergence. Direct Process uses details through almost all pixels. The item iteratively improves an estimate connected with homography & ensures that particular cost functionality is usually reduced. From time to time Phase-Correlation can be used to be able to estimate the couple of variables on the homography.

Feature-based techniques

Throughout feature-based method, almost all main attribute details in picture pair is usually compared with almost all characteristics inside other picture by utilizing among the local descriptors. For picture sewing according to feature-based tactics, attribute extraction, registration, and also blending together are wide and varied steps important for doing picture sewing. Feature-based approaches are utilized by establishing correspondences among details, lines, tips, 4 corners or even any other forms. The key features connected with study alarms involves invariance to picture noise, level invariance, translation invariance, and also rotation transformations. There are many attribute detector techniques are present some of which are, Harris [5], Scale-Invariant Element Change (SIFT) [2], Speeded Upward Robust Features (SURF) [5], Features through More rapid Part Test (FAST) [7] and PCA-SIFT [6].

The benefit of attribute based method is usually that it's more robust next to any type of landscape mobility occurred with picture. This method is more quickly able to identify panoramas by routinely uncovering the adjacency relationship among a requested list of pictures. These types of characteristics are generally suitable with regard to thoroughly robotic sewing connected with panoramas.

The fundamental favorable position of feature based strategy is that it is more powerful against a scene development happened in picture. This technique is quick and it can perceive displays via consequently identifying the nearness relationship between requested arrangements of pictures. These elements are most appropriate for completely computerized sewing of scenes. Highlight construct techniques with respect to exact recognition of picture elements. Correspondences between elements prompt to calculation of the camera movement which

can be tried for arrangement. Without particular elements, this sort of approach is probably going to come out short.

Element based approaches make use of appropriate discovery connected with picture characteristics. Correspondences among characteristics working out on the photographic camera action can be examined with regard to alignment. In the lack of unique characteristics, such a technique will probably crash.

3. RELATED WORK

Based on Direct Technique

Chen Kaili Wang Meiling et. al., [11] offered “Image stitching criteria analysis depending on Available CV”. In this particular stitching, procedure for starter’s element removal is developed by means of Harris corner detection and show is usually matched up by choosing the normalized cross correlation involving them. From there on RANSAC (Random Sample Consensus) can be used to remove these outliers &also to get rid of the error matching. Last but not least this weighting regular method [12] can be used to blend this image. Depending on this assert of the cardstock that criteria minimizes the Computational complexity of image merging and the Overlapping charge of photos

Yang Di, Bo Yu-ming, Zhao Gao-peng et. al., [13] recommended the process triumph over this restriction connected with sift my partner and is the delicate to be able to no linear illumination changes. With this approach to begin with characteristic items usually are taken out by SYFM (a community proportion dependent descriptor) and SIFT (gradient dependent descriptor) [14]. Then SIFT descriptor as well as community proportion usually merged to be able to define these characteristic positions. After that characteristic coordinating will be carried out by “randomized k - d trees” as well as convert parameters usually are measured by correct interior items following RANSAC had been employed to do away with incorrect meets. In the last image stitches will be completed with smoothing formula. This process possesses increased coordinating precision than SIFT (scale invariant characteristic transformation) as well as SURF (speeded upward robust features) beneath no linear illumination change examples and will achieve better effectiveness inside image stitches.

Taeyup Melody, Changwon Jeon; Hanseok Ko et. al., [15] proposed the challenge of illumination improvements coming from distinct exposures. On this approach characteristic points are generally taken out by means of sort and by making use of k - d lookup woods algorithm and nearby neighbor algorithm characteristic points are generally matched there after the outliers are generally taken away using the story characteristic related algorithm.

Fei Lei, Wenxue Wang, et. al., [16] planned this technique within the first task feature factors are usually taken out by simply waves operator and feature factors are usually matched up by simply best can initial algorithm [17]. Picture enrollment is accomplished by simply price the particular switching connection involving graphics by employing ransac and also least squares technique. Within the last few move the particular picture is amalgamated by employing within and also away combination criteria which in turn makes your final stitched picture.

Niu Jing et. al., [18] used the LOOK formula to help apply the feature-based graphic stitching program. The first task within the breathtaking acknowledgement formula is always to draw out and also fit LOOK functions among all the pictures. LOOK functions are located with scale-space maxima/minima of an difference of Gaussian functionality, and then the intention of 2nd step “image matching” is always to come across almost all coordinating (overlapping) pictures, it’s merely essential to fit every single graphic to help a small amount of nearby pictures to achieve a good solution for that graphic geometry. Next, they will used RANSAC to select some inliers that are compatible with the Homograph between your pictures. From then on, they will applied

the probabilistic type to help verify the fit; chances are they'll use bundle modification to resolve regarding all the digital camera details with each other; lastly they've applied the multi-band blending approach. The thought driving multi-band blending is always to combination small frequencies over a huge spatial array and also excessive frequencies over a quick array. This could be performed above a number of regularity artists having a Laplacian Pyramid.

Based on Feature Based Technique

Eden et. al., [21] presented a technique to help immediately stitch a number of pictures with numerous orientations and also exposures to create a blend panorama which maintains the angular extent and also powerful variety of the inputs. Your suggested method enables huge direct exposure differences, huge landscape motions or maybe some other mis-registrations among supports and also needs no additional digital camera equipment. To achieve this, they will release the two-step chart lower method. The purpose of the initial step is always to resolve the jobs of shifting physical objects within the landscape. Inside the 2nd step, they will fill in the whole obtainable powerful array.

Lowe [20] prolonged his/her previous simply by introducing automatic image stitching and also programmed styling actions. That they demonstrated the way to solve for any photometric parameter, such as the general attain among pictures, with a malfunction functionality described total pictures. Your malfunction functionality can be the sum attain normalized high intensity mistakes for everyone overlapping pixels.

Deepak Jain [23] suggested a large part way of graphic mosaicing. The following, he'd used about three step approaches. In 1st step, they take a couple pictures and find corner of equally these pictures. In 2nd step, it taken out the false corner by equally pictures. Lastly, used Homography to find harmonized corner and find mosaic graphic.

Yanfang [22] concerned about the difficulty of programmed graphic stitching that mainly is true of the graphic string even people which includes noises pictures. This individual used one way based on invariant functions to achieve fully programmed graphic stitching, where it provides a couple major components: graphic coordinating and also graphic blending. For the reason that sounds pictures have got huge differences between your some other pictures, when using LOOK functions to achieve accurate and also strong coordinating, this offers a probabilistic type to help verify the panorama graphic string. Your stitching good quality can be tested aesthetically from the likeness on the stitched graphic to help every one of the suggestions pictures, and also from the field of vision on the seam between your stitched pictures. In order to define and find ideal stitching, many conventional price tag functions for that analysis on the stitching good quality tend to be released in this paper. In these price tag functions the likeness towards suggestions pictures plus the field of vision on the seam tend to be described within the gradient website, lessening the worrisome edges down the seam. A good graphic stitching will boost these price tag functions, beating equally photometric incongruencies and also geometric misalignments between your stitched pictures.

Vimal Singh [23] presented a technique regarding feature-based graphic mosaicing using graphic fusion the spot that the suggestions pictures tend to be stitched jointly when using the popular stitching algorithms. To be able to draw out the most beneficial functions merely from the stitching outcomes, the blending procedure is performed with wavelet Enhance (DWT) when using the greatest collection tip regarding equally approximate and also detail-components. Your robustness and also good quality on the previously mentioned mosaicing methods tend to be examined with three-dimensional rotational pictures. The functional analysis of suggested method is performed with regards to PSNR (peak signal-to-noise ratio), FSIM while High quality Calculate regarding Merged likeness, MI (Mutual Information), EME (Enhancement functionality measure), NAE (Normalized Overall Error) and also SD.

4. CONCLUSION AND FUTURE WORK

The study tells the improvisation which is needed in the current techniques, as the focus is mainly on the stitching of the nonlinear edge based features and increase the probability of the detected features to be of the shortest projection in comparison to the second or consecutive image. This is highly promising to be implemented in the SIFT and corner detection system as the number of features required for the stitching or panorama creation are more prominent and highly dense, which is a result of the wide use of these algorithms in most of the panorama creation applications.

In future, the horizontal projection and RANSAC both can be optimized in time as well as ghosting creation due to consecutive stitching, this may improve the shadowing or superimposition of similar content resulting in a wide non discrete canvas with user needed quality for HD image creation.

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