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Comparison of the Work Process Methods for Scale Invariant Feature Transform and Sum of Squared Difference in Image Mosaic

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ABSTRACT

Mosaic image is an image made from a collection of many other small images placed side by side, so that from a distance it looks like one big image. The use of this mosaic image varies, for example in digital image processing, in the context of image analysis, mosaic can also mean the process of combining several images with overlap to create one large image, for example in geographic mapping using satellite imagery. Then as a pattern creation in the field of design, mosaic images are used to create complex or abstract patterns, which can be used in decoration, architecture, or product design. Mosaic image is a combination of several images to get a wider view. One of the problems in mosaic image is in the image matching process, the right image matching can produce a better mosaic image. This study will compare the image matching method with RANSAC and SSD. The mosaic image of both methods was tested using objective fidelity criteria. The results showed the RANSAC method with an MSE value of 121.5820 and a PSNR value of 27.2821 dB, while the SSD method with an MSE value of 140.8373 and a PSNR value of 26.6436 db. The RANSAC algorithm is good for use in cases of mosaic images with feature-based methods, while SSD is good for use in cases of mosaic images with direct methods.

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INTRODUCTION

Humans have the sense of sight to see objects visually. The object is captured by the eye in stereo, where the angle of view of the object seen by the left eye and the right eye will be combined and processed by the brain so that it becomes one complete view[1]. The use of a digital camera to capture the object is very necessary so that the object can be seen permanently and the acquisition results are stored in a file so that it can be used for further processing[2]. In capturing images using a camera, there are still shortcomings, where the results of capturing images are limited to the field of view, to overcome this problem, an image capture technique is needed which can later be combined into a longer and more complete image[3].

Mosaic images are often used to create portraits of famous people or as a form of tribute, where a large image is made from photographs of many people or historical moments[4]. Digital Image Processing: In the context of image analysis, mosaic can also mean the process of combining multiple images with overlap to create one large image, for example in geographic mapping using satellite imagery[5]. Pattern Creation: In the field of design, mosaic images are used to create complex or abstract patterns, which can be used in decoration, architecture, or product design[6].

Mosaic image formation is basically the process of combining several images, where one image has several similarities with other images, so that the results of the combination produce a new image with a wider viewing angle[7]. Many methods have been used in the formation of mosaic images, including using the Cylindrical and Spherical Panoramas method, Perspective (8-parameter) Panoramas, Rotational (3-Parameter) Panoramas[8]. Other researchers use the Harris Corner Detection and Scale Invariant Feature Transform (SIFT) methods, and the results of the SIFT method are superior to Harris Corner Detection. This study uses SIFT for point initialization and Sum of Squared Difference (SSD) for image matching[9].

Mosaic image formation is basically the process of combining several images, where one image has several similarities with other images, so that the results of the combination produce a new image with a wider viewing angle[10]. In a similar study using the Harris method, SIFT Feature Detection for point initialization, and comparing the two methods with several parameters including PSNR (peak signal-to-noise ratio), MI (Mutual Information), NAE (Normalized Absolute Error), FSIM (Feature Similarity Index Measure), SSIM (Structural Similarity Index Measure) and EME (Enhanced performance Measure)[11]. From this comparison, the Harris algorithm is suitable for images with rotation invariant and detects a larger number of features with simple calculations, while the SIFT algorithm has the properties of affine, rotation invariant and scale invariant[12].

Further research using the basic method used to generate panoramic images. The purpose of this study is to provide different methods and algorithms used to generate panoramic images and also to present new mosaic images based on the SIFT algorithm and the Corner Detection algorithm[13]. When there are variations in scale and rotation, SIFT can provide better performance and when without rotation, the Corner Detection algorithm can perform better[14].

The next similar study is to apply an approach to create a full mosaic view of a sequence of color images through corner detection. With a complete methodology divided into various stages including Contrast Adjustment and Noise Reduction, Grid Formation, Registration of image grids, Selection of Control Points (Corners), and Stitching[15]. The methodology for creating panoramic images can be applied to noise and low-contrast image grids. This process begins with a 2-grid that can be extended according to image needs. Image registration is done between geo-referenced image grids[16]. Merging is done between the corners of the grid. This corner is the control point of the mosaic image.

METHOD

To solve the case, the author will carry out the stages in solving it. The solution path through the results of the research can be seen in Figure 1 below:

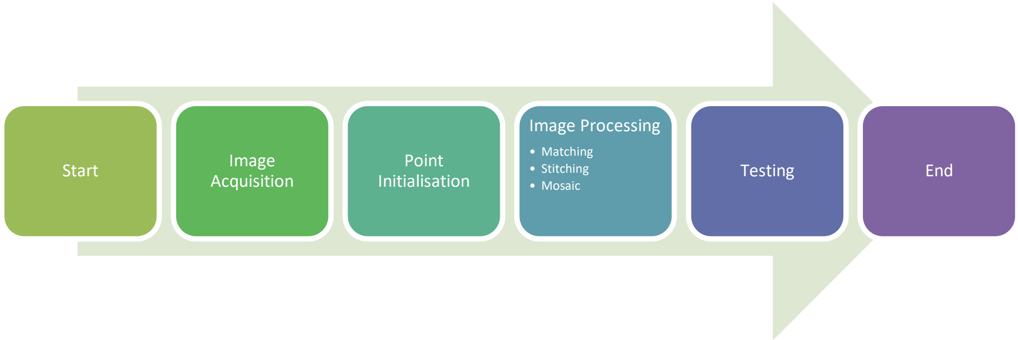

Figure 1. Image Mosaic Model Discussion Flow

Details in the Image Mosaic Moel discussion flow:

1. Image Acquisition

Image acquisition is the process of capturing images from external sources using hardware such as cameras, scanners, or other sensors. This process is the initial step in digital image processing, where images are captured for analysis, processing, or use in further applications. This step is by photographing the same image but taken from several sides that correspond to each other.

2. Point Initialization

Point initialization can be done manually or automatically, in this study it was done using the SIFT algorithm so that a unique point is obtained which is the key-point of the image.

3. Image Matching

This point matching is done in two ways, namely with SSD and the RANSAC Algorithm. Image matching is the process of identifying and matching similar features or elements between two or more images. This process is used in various applications that require comparing, recognizing, or merging images.

4. Image Stitching

Image stitching is done by overlapping. Image stitching is the process of combining multiple overlapping images to create one large, seamless image. This process is typically used to create panoramas or wider images than a single camera or lens can capture in a single shot.

5. Image Mosaic

After the image merging and smoothing are done, a mosaic image can be obtained. The results that appear in the mosaic image will be tested in the next stage

6. Testing

Testing is done using objective fidelity criteria. In this test, the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) values of the mosaic image are calculated.

RESULT & DISCUSSION

Based on the solution flow with the method mentioned previously, the following results can be obtained:

1. Image Acquisition

Image acquisition was done with the help of a Canon Power Shot D3000 digital camera, 16 Megapixels. The results of image acquisition can be seen in Figure 2.

Figure 2, Sample image capture on the right and left sides.

The next step is to enter the acquired image into the Matlab R2012 software. The command to enter the image is as follows:

I1 = imread('Left Image.*jpg')*
I2 = imread'('Right Image.*jpg')*

Meanwhile, to display the image with the following command:

figure(1),imshow(I1)
figure(2),imshow(I2)

2. Point Initialisation

This point initialization is done using the SIFT algorithm, with this algorithm the unique point (keypoint) of the image is obtained. The unique points of the image can be seen in Table 1.

Table 1, Key-points in the sample image "Photo of Yogyakarta Monument"

Image	Dist. Ratio	*Key-point*		Match
		Left Image	Right Image	
Photo of Yogyakarta Monument	0.1	1524	3174	0
	0.2	1524	3174	16
	0.4	1524	3174	190
	0.6	1524	3174	327
	0.9	1524	3174	669

From Table I, by changing the distribution parameters of the ratio of the spread of unique features in the image with a range of 0.1 – 0.9, the author takes a value of 0.6.

3. Image Matching

Image matching with RANSAC algorithm. In this image matching, it is done by determining the ratio distribution of 0.6, obtained 327 match points, Figure 3,

Figure 3. Image matching results.

Next, image matching is performed with SSD. In this image matching by searching for the appropriate template area, the template is obtained on the right image and then scanned against the left image, so that the same area is obtained on the left image and the right image. Figure 4 shows the appropriate template area.

Figure 4. Match the Image of the Yogyakarta Monument with SSD.

From matching the corresponding images, the homography matrix can be obtained as follows:

$$\text{Homography\_Metric} = \begin{bmatrix} 0.0022 & 0.0001 & -2.0510 \\ 0.0004 & 0.0020 & -0.6335 \\ 0.0000 & 0.0000 & 0.0010 \end{bmatrix} \quad (1)$$

After obtaining the homography matrix, the next step is to transform the left image with the matrix, so that an image like figure 5 is obtained.

4. Image Stitching

The next process is image splicing by rearranging the pixels between the transformed left image and the right image. Figure 5 is the image that will be combined.

Figure 5. Match Image combination of Yogyakarta monument with SSD.

5. Image Mosaic

Mosaic image is a combination of two or more images that are made into one so that the image looks wider. To combine several images cannot be done simultaneously, but by processing two images first, then the mosaic image results are combined with the next image. Figure 5 in the previous discussion is the result of a mosaic image. The results of the two image connections with matching using SSD previously produced the following Objective Fidelity Criteria:

Table 2, Result Objective Fidelity Criteria.

Image	Method	Value	
		MSE	***PSNR***
Photo of Yogyakarta Monument	*RANSAC*	121,5820	27,2821
	SSD	140,8373	26,6436

6. Testing

The results of the mosaic image test can be seen in Table II above. The results of the MSE and PSNR calculations on the Tugu Yogyakarta image using the RANSAC and SSD methods show that the RANSAC method is better. The RANSAC algorithm is suitable for mosaic image cases with feature-based methods, while SSD is suitable for mosaic image cases with direct methods. Using the two methods above, it can be seen that there is a difference in light intensity in the joint area, this is because when taking the picture the light intensity of the room is not the same, but this does not affect the results of the joint process, but aesthetically it looks less good. To improve the joint area, further image processing is needed so that the light intensity in the joint area looks more even.

CONCLUTIONS

From the results of the research conducted, several conclusions can be drawn as follows, (1) The RANSAC algorithm is good for use in cases of mosaic images with feature-based methods, while SSD is good for use in cases of mosaic images with direct methods. (2) Light intensity does not affect the image transformation process so that a mosaic image is still obtained, but aesthetically it looks less good in the joint area.

One of the main advantages of RANSAC is its ability to handle data with many outliers. In image processing, outliers can arise due to noise, irrelevant objects, or imperfections in the image capture. RANSAC can effectively ignore outliers and focus on inliers (data that conform to the expected model). RANSAC can be used for a variety of models and applications in image processing, such as line detection, estimation of geometric transformations (e.g., hemograph in image stitching), and feature matching. This flexibility makes RANSAC very useful in many situations.

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