Automatic Image Stitching of Agriculture Areas based on Unmanned Aerial Vehicle using SURF

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Abstract. Identification of agricultural areas in remote sensing technology is needed for the development of agricultural areas. The image of the agricultural area in this study uses an Unmanned Air Vehicle (UAV). The results of images taken from a height of 100 meters on the ground will be stored and processed into one image. UAV technology that supports this research is expected to help remote sensing in real time. For the current study, measurements in agricultural areas are related to some fragmented images. This article creates a beautiful view of the agricultural region. The author focuses on automatic image milling methods with detection-based image matching and description of patented local features from the dataset. The features method applied is based on speeded up robust features (SURF). The method of matching images and verification results is carried out. The result will create a 2-D spatial reference that starts the panorama size. This paper shows the results of image stitching in the agriculture area.

1. Introduction

At present Airless Vehicle has developed rapidly and is widely applied in various applications, namely remote sensing, such as seeing electricity networks, making improvements in an area, seeing regional geological conditions, and observing agricultural land [1]. Other examples of responding to disasters, tracking damage caused by floods and monitoring forest fires, carrying out legal oversight, such as location, traffic, country, maritime and border patrol information. UAV can be developed as a reliable technology that provides functions and benefits for development in other cases.

For reliable technology, it is necessary to develop various capabilities to help humans utilize and maximize the function of unmanned aerial vehicles, one of which is to take photogrammetry, as long as photogrammetry is taken from satellites, the problem is often constrained by cloud cover, especially during the rainy season. Besides that, dependence on satellite data requires large costs and slow data acquisition, causing information to be delayed [2]. Aerial photography using unmanned aircraft is one of the alternative technologies to get more detailed, real-time, fast and cheaper, using an unmanned aerial vehicle equipped with a camera is one alternative to identify an area for various purposes [3].

The method that can be used in the application of the image of the UAV has been widely used in other studies such as building panoramas, paintings, other objects that are visible [1]. The applied research usually uses invariant features-based merging techniques [4] [5] [6]. In this paper, the authors propose the SURF method for the implementation of the UAV image. SURF is the development of the SIFT method that first appeared. The object used as a trial was taken from the agricultural area in Jember

Regency. The process of applying this research consists of related research parts, methods applied, trials results, and conclusions.

2. Related Work

In the study of unmanned aerial vehicle carrying payload which consists of integrated equipment such as various sensors, cameras, surveillance devices and the like that have the ability to take digital images. UAV are widely used to monitor natural resources. UAV are easily available, and can reach large areas, with relatively small sensor equipment, GPS, and other related hardware. UAV can achieve full autonomy and are given intelligence. Full autonomy means making a temporary landing of an aircraft that is usually difficult to control, take off, and navigate the autonomous waypoint. Control operators carry out the supervision process for mapping [2]. So far UAV have been used to obtain remote sensing images for the development of agriculture areas such as monitoring fires and natural disasters, measuring the area of vegetation, plants, and forests. The image quality and resolution produced by UAV depend on the height of the device, as well as the type and characteristics of the sensor [3].

Other related research on UAV Remote Sensing in the acquisition and monitoring of agricultural information. The research uses SIFT algorithm for UAV remote sensing mosaics and its application in agriculture [3]. However, it needs to be examined further, other methods of application and the detailed stages of the remote sensing process that will be applied, such as the preprocessing process, image registration, matching, mosaic model, and real-time area

3. Method

The method in this study consists of the steps to be processed. The general process steps can be seen in Figure 1. The first step, the data will be acquired using a fixed-wing type UAV that has been described in part 2. The second step, the captured image from the path is processed to map and register. The steps taken are detecting and matching the sequence of images that are paired. The third step, matching the image of point image register. The last, image stitching from the results of the previous process. This process combines features that are matched to build a suitable agricultural region Panorama.

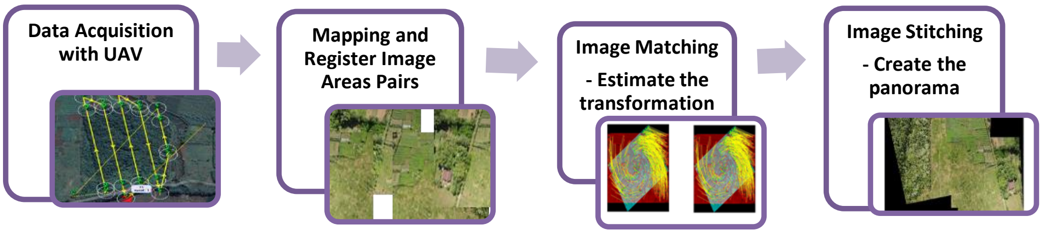

Figure 1. Block Diagram of Automatic Image Stitching of Agriculture Areas

3.1. Image Mapping of Agriculture Areas using UAV

The Image mapping process uses a fixed-wing UAV type with the pylon model (IR-JET64). Fixed wing has the shape of an ordinary airplane equipped with a wing system. This type of UAV is shaped like a commercial aircraft and is used for fast processes, faster and wider range, used for mapping or concepts such as scanning. Fixed wing UAVs have more efficient battery energy because of the single propeller, and more efficient aerodynamics [7]. The type of aircraft used for image mapping in the agriculture area can be seen in Figure 2 (a). The camera used is Sony DSC-WX220. The road pattern used for mapping the agriculture area can be seen in figure 2 (b). UAV vehicles fly autonomously following the specified waypoint path (figure 2 (b)). The position of the camera is mounted perpendicular to the ground surface as high as 100 meters.

(a) (b)

Figure 2. (a) A fixed-wing UAV Type, (b) Area mapping route or Home location

3.2. Register Image Area Pairs and Image Matching

Registration is carried out using the feature determination procedure between *P(n)* and *P(n-1)*, performing a geometric transformation, *T(n)*, which maps *P(n)* to *P(n-1)*, calculates transformations that map *P(n)* into the stitch image as:

$$T(1) * \ldots * T(\text{n-1}) * T(\text{n})$$

The detected features are initialized to match. Matrix identification transformation process. Panorama Results Stitch images are obtained by combining transformation techniques that are matched with each detected feature. The automatic process looks for the output limit for each transformation. The output limit then used to find a centralized image. It is possible to get the position to be combined into a panoramic image [8].

The SURF feature is a key point of an image. Key point combines the points of an image whose value still when there is a change in scale, rotation, blurring, lighting, and also shape changes. Transformation can occur due to several factors. These factors can occur because the shape of the image is not intact, there are other objects that cover, imperfect shooting, or the state of the object itself that changes. In order to be invariant to change scale, the first step the process is made a scale space. Keypoint localization is done by several processes. The first process, determines the threshold for keypoint When the threshold is increased the number of keypoints detected is smaller and vice versa. Therefore, the threshold can be adjusted for each application. The limit value of each axis is also determined by the x and y axes. Find the minimum and maximum values of the specified output limits. The size will be formed according to the initialization that has been determined from the value that has been obtained [8].

In the SURF algorithm, a detector of attention points that has invariant properties of the scale is chosen, namely blob detection. Blob is an area of digital image that has a constant or variable nature within a certain range. To do this blob detection computing, the determinant of the Hessian matrix (DoH) is used from the image [9]. If given the point x = (x, y) in image P, the Hessian matrix H (x, σ) on x with the σ scale is defined as:

$$H(x,\sigma) = \begin{bmatrix} M_{xx}(x,\sigma) & M_{xy}(x,\sigma) \\ M_{xy}(x,\sigma) & M_{yy}(x,\sigma) \end{bmatrix}$$

where *M(x, σ) xx* is the convolution of the second derivative of the Gaussian function $\frac{\delta^2}{\delta x^2}\, g(\sigma)$ with image *P* in point *x*. This definition also applies to *M(x, σ) xy* and *M(x, σ) yy*. Gaussian function is defined as:

$$g\,(\sigma) = \frac{1}{\sqrt{2\pi\sigma}}\, e^{\frac{x^2}{2\sigma^2}}$$

In the SURF algorithm, the Hessian matrix determinant is calculated from the Haar wavelet by optimally using the integral image. The determinant of the Hessian matrix is used as the basis of the SURF algorithm because of its invariant nature to scale, stability and repetition easily [10].

3.3. Automatic Image Stitching

Image Stitching can be referred to as a mosaic image of two or more images that are made together so that the image looks wider or is referred to as a panorama. To combine multiple images cannot be simultaneously, but by processing two images first, then the results of the mosaic image are stitched with the next image. The process is created a 2-D spatial reference object that defines the panorama size and change panorama. The process has created a mask for overlay operations and cleans the edge artifacts in the mask, and then turn them into binary images. The final result layout curved images to panoramas.

4. Experimental Result

The experiment was conducted at the forest mapping location of the city of Ajung sub-district, Jember Regency, East Java. Geographically the location of the City Forest is at 8˚12 '54 "S 113˚39'54" E. At the time of the felling test at the UAV vehicle, the input parameters in the Mission Planner must be done first, so that a waypoint path is obtained that matches the urban forest mapping. After the mapping process has been successfully carried out, a sequence of images that are still fragmented are collected. At the time of the felling test at the UAV vehicle, the input parameters in the Mission Planner must be done first, so that a waypoint path is obtained that matches the urban forest mapping. After the mapping process has been successfully carried out, a sequence of images that are still fragmented are collected. The resulting image consists of 164 with the image dimension 2592×1944. From the experiment it was tested to produce image stitching which can be seen in Figure 4. From some of the images that are processed it becomes 3 parts to extract the features and match them. The sequence section generated in Figure 3.


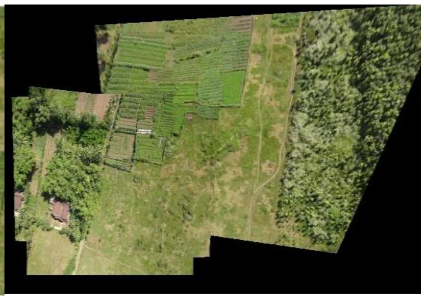

Figure 3. Sample Register Image Areas Pairs Sample

Figure 4. Image Stitching Result (Panorama of Agriculture area)

Comparative results of the area tested using SURF can be seen as keypoint and image stitching generated in table 1.

Table 1. Results of Automatic Image Stitching using SURF.

	Height	Width	MatchedPoints	Keypoints 2	Keypoints 1	MSE	Time
Area 1	3238	5421	109	7078	2076	0,01907	12,386583
Area 2	3159	6718	353	9378	7078	0,00547	44,680187

5. Conclusion

City Forest Mapping with UAV vehicles is able to follow the waypoint path autonomously well. UAV can fly based on the configuration that has been determined in the Auto WP configuration based on the Grid Survey. The configured Survey Grid produces 6 flyways that will be taken by UAV vehicles based on the camera used. Using Over Shoot 30m, with Overlap and Side lap at 65%. City Forest Mapping with UAV vehicles produces 164 aerial photographs.

Image stitching that is processed using SURF shows a clear image density formed (figure 4). Amount change transformation point is very influential on the number of true images. For SURF feature extraction, the higher the number of points, the higher the number of true images. Deepening of the method in determining features for matching an image stitching needs to be re-examined to get the appropriate results. When image stitching is successful, the process of determining the area can be developed as an area of agriculture development or other.

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