Free and Open Source Software for Geospatial (FOSS4G) Conference Proceedings

Volume 15 *Seoul, South Korea* Article 48

2015

A Comparison of Image Aligning and Correcting Software with an Unmanned Aerial System

Kangsan Lee
Department of Geography, Kyung Hee University

Jinwoo Park
Department of Geography, Kyung Hee University

Jinmu Choi
Department of Geography, Kyung Hee University

A Comparisonof Image Aligning and Correcting Software with an Unmanned Aerial System

Kangsan Lee[1], Jinwoo Park[2] and Jinmu Choi[3]

[1]Department of Geography, Kyung Hee University
26 Kyungheedae-ro, Dongdaemun-gu, Seoul, Rep. of Korea
Email: gi.star@khu.ac.kr
[2]Department of Geography, Kyung Hee University
26 Kyungheedae-ro, Dongdaemun-gu, Seoul, Rep. of Korea
Email: zawoon96@khu.ac.kr
[3]Correspondence, Department of Geography, Kyung Hee University
26 Kyungheedae-ro, Dongdaemun-gu, Seoul, Rep. of Korea
Email: cjm89@khu.ac.kr

ABSTRACT

In the past few decades, many kinds of UAS for image acquisition have been developed. But software for image aligning and correcting is mostlyhigh-cost commercial. This problem caused the cost-problem in using UAS. Nowadays, a variety of software, not only commercial but also open-source, provides powerful image processing tool. There are a number of software to support image processing. In this study,five popular programs are testedfor comparison. The goal of this study is to compare popular open-source software based on the ease use, overall accuracy and processing time for chunk of images from UAS.

1. INTRODUCTION

Traditionally, as a data collection platform, aircraft and satellite have a major role in remote sensing. However, these remote sensing platforms have structural problems: time and cost. More specifically, researchers have to spend a lot of money to get high-resolution images. Furthermore, because of some constraints, such as weather condition, sometimes these platforms or images from the platforms may be useless(Jensen, 2009). In these circumstances, the new remote sensing platform has been rising; UAS, Drone.

The word, UAS is an abbreviation of Unmanned AircraftSystem(Marshall *et al.*, 2015). Many researchers have been focusing on 'Unmanned'(Martinez Rubio *et al.*, 2005; Vierling *et al.*, 2006; Zhang and Kovacs, 2012). Especially, it is necessary in a certain situations where people cannot access. For example, researchers used UAV as a landslide investigator in the Southern French Alps (Niethammer *et al.*, 2012).

After gathering images from UAS, the researchers should stitching images for further research. This is because gathered images from UAS is not a whole scene of the entire research area; UAS is moving around over the ground while the shutter of the camera worked. Therefore, the single images should be matched among each other to composite large single image dataset.

There are a variety of software which can handle this work, many researchersuse these image processing programs in various areas: Engineering(LeBlanc *et al.*, 2013), Medicine(Wójcicka and Wróbel, 2012), and Geomorphology (Niethammer *et al.*, 2012).However, we don't know much about which software we choose to process our UAS images. Thus, this study aims to compare several image stitching software using sample images gathered by UAS. It is expected that the result of this comparison provides a solution which software is better for UAS-gathered image stitching.

2. DATA ACQUISITION

2.1 Image gathering

Before image alignment and stitching, the images were collected by UAS. In this study, one of the famous open-source UAS, 3DR Robotics IRIS+, and small digital camera, Gopro, were used. IRIS+ is composed of four propellers and Pixhawk controller. The benefits of the Pixhawk system include integrated multithreading, a Unix-like programming environment, completely new autopilot functions such as sophisticated scripting of missions and flight behavior(Meier *et al.*, 2012). With these hardware environments, 'Mission Planner' has a significant role in data acquisition. In fact, there are so many limitations in manual control.The UAS should be controlled by the user-defined flight route to get accurate images in the research area. However, in manual control mode, it is impossible to maintain fixed altitude, azimuth and speed. Therefore, this study uses the Mission Planner to control autonomous flight. These hardwares and software are shown below (Figure 1).

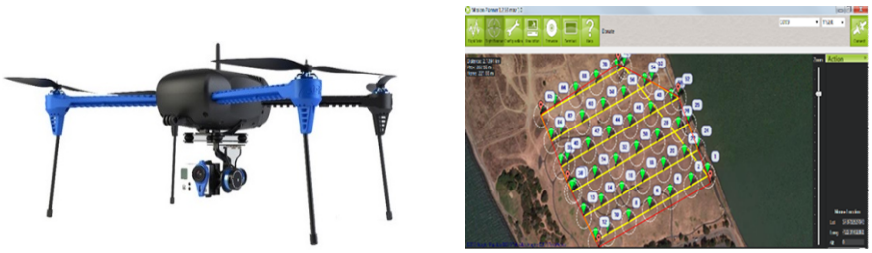

Figure 1. IRIS+ and GoPro (Right), Mission Planner for autonomous flight(Left)

Using the hardware and software system, approximately 200 images were collected in the sampling area. Regarding to the law of Korean Aviation, controlling UAS in urban or public area is illegal. Accordingly, the sample images were taken in the rural area, Baramarae beach, located in the west coast of South Korea.

2.2 Correcting lens distortion

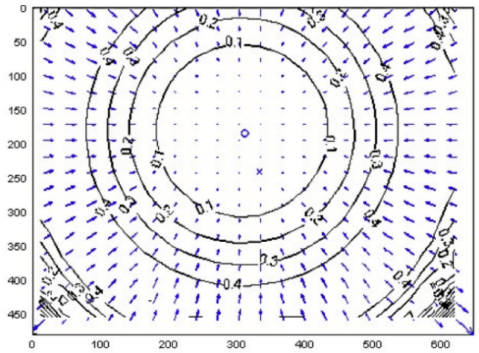

Figure 2. Radial distortion (California Institute of Technology, 2011)

GoPro, small digital camera has a lens distortion(Tauro *et al.*, 2014). As shown in Figure 2, lens distortion should be removed before image alignment. Although many image processing programs provide fixing tool for lens distortion, the Adobe Lightroom program is selected to correct lens distortion. This is because some program shows slow processing speed and do not remove the distortion efficiently. Photoshop Lightroom, shows high-speed performance with pre-defined lens information: focal length and distortion factor. As a result,

all sample images were transformed into adjusted images with the same quality automatically (Figure 3).

Figure 3. Lens distortion correction (before – later)

3. IMAGE ALIGHNMENT

The main purpose of this study is comparing several image alignment software with sample images. Specifically, many commercial and open-source image alignment program have been developed for image alignment. But each program has their own characteristic; for example, some of them is only suitable for making panoramic photos, image stitching and image mosaicking. So, many researchershaveencountered that 'Which software should I select to do image alignment for the UAS-gathered images?'

One of the solution tothis question is comparing several software at the same hardware environment. The workstation environment is stated in Table 1.

Table 1. Specification of the testing environment

Component	Specification
CPU	Intel Xeon CPU E3-1231 3.40GHz
RAM	16GB(DDR3, Dual Channel)
GPU	GeForce GTX 750Ti
Cuda Core	640
Storage	SSD, 256GB

3.1 Image alignment software

Among the variety of image alignment software, five major software are tested for comparison.Specific information about these programs are stated in Table 2. The first one isAgisoft Photoscan, one of the famous commercial image stitching program. It is mainly used for three dimensional image making based on a conjugate-point calculation between adjacent images. After building point clouds and image pyramids, anorthophotograph can be generated.

Table 2. Software information

Name	Developer	License	Notes
Photoscan	Agisoft	Proprietary	Using photometry method
Photoshop	Adobe	Proprietary	User-friendly interface
Image Composite Editor	Microsoft	Proprietary (Free for non-commercial use)	Variety of pre-defined projection

Hugin	Pablo d'Angelo et al.	GPL	Based on panorama tools
Pix4Dmapper	Pix4D SA	Proprietary	Optimized for UAS

Second, Adobe Photoshop also has a photomerge function in automatic image processing tab. This is not a professional image stitching program, but many people use it to enhance image quality. In this perspective, Photoshop may be a useful software for public.

Third, Image Composite Editor (ICE), developed by Microsoft, is not an open-source program, but free software. The characteristic of this program is that it has plenty of pre-defined projection. Also, it provides lots of image format. So, users can choose what they want to make just using a user-friendly GUI system.

Fourth, Hugin is the most famous open-source image stitching program. Both the amateur photographers and professional researchers used to utilize this software. The biggest advantage of Hugin is that this is a free open-source program; users can use it free-of-charge.

Lastly, Pix4D image processing software is a mapping and modeling solution to convert thousands of images into a georeferenced 2D mosaic and 3D models. In these days, several UAS companies have a collaboration with the company of Pix4D software. It shows that this is a powerful image stitching software with a UAS system. But this commercial program has a cost-problem.

3.2 Comparing image stitching software

With these five image stitching programs, several comparisons have been done; image stitching time, image volume, and image quality.

Two hundredsample images were gathered usinga UAS. To compare image stitching processing-time for each software, a comparative experiment was designed; the amount of input data had been changed from 50 to 200 increased by fifty. It is reasonable that the bigger the volume of input data increased, the longer the processing time required. However, this experiment is useful to figure out individual software's performance (stitching time) and accuracy (quality of result). Figure 4 describes a concept of the experiment.

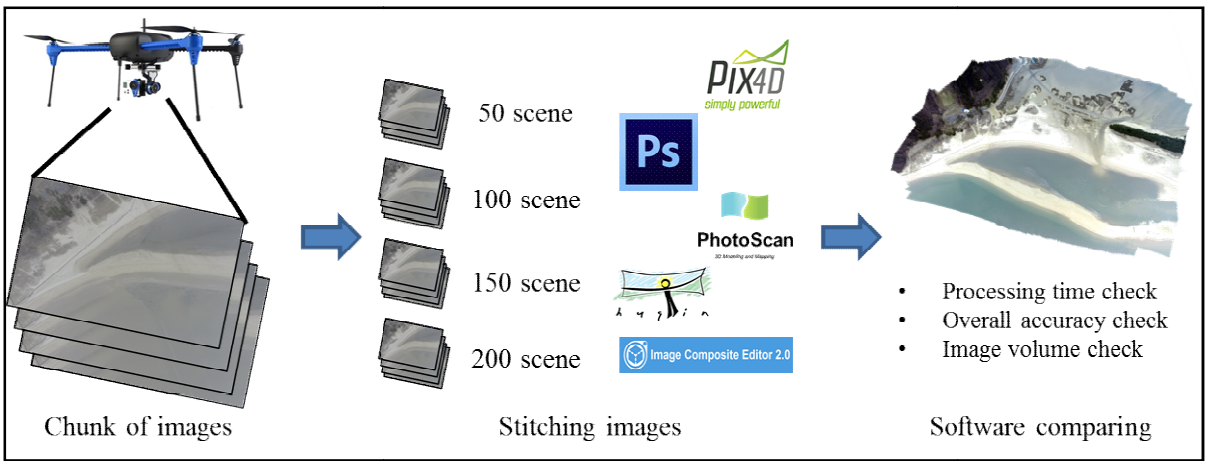

Figure 4. Concept of software comparing experiment

3.3 Result

Unfortunately, Hugin among tested five programs doesn't show powerful functions when it comes to stitch images. This is because its original purpose is not a photogrammetry work, but making a panoramic image. More specifically, Hugin does not estimate conjugate

points between adjacent images that have coarse overlapping terrain features, then it cannot calculate a relative orientation with a chunk of shoreline images. Moreover, Photoshop cannot success to stitch 200 images because of hardware limitation: not enough memory and CPU performance.

The resulting graphs (Figure 5) show that how processing time and image volumes had been changed depending on the number of input images and processing programs. In brief summary, processing time and image volumes are gradually increased in all softwareaccording to the number of images, but not proportionalto the number of input images. But the rate of increase of time and volume shows differences among the program. MS ICE shows the fastest performance and has the least image volume. On the contrary, Pix4D is getting much slower and the results of Photoscan have a huge image volume.

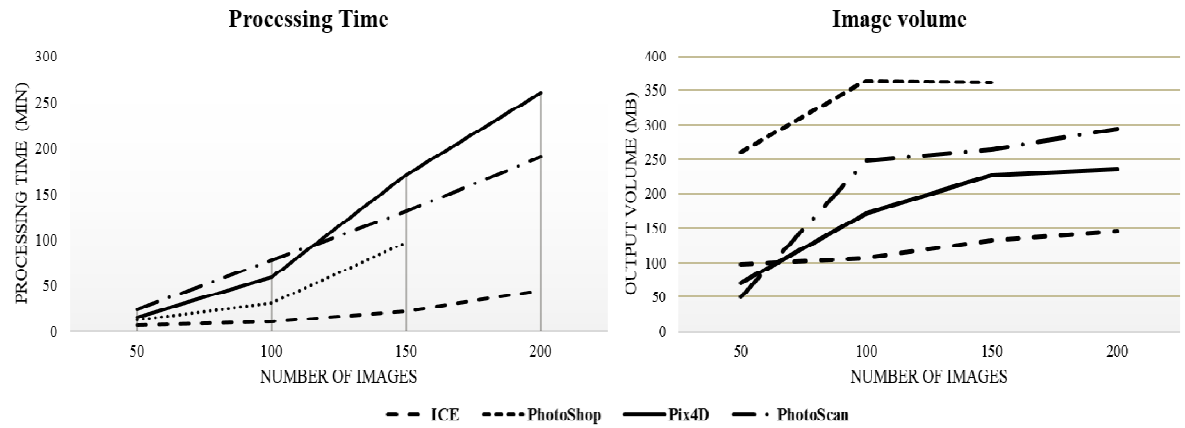

Figure 5. Processing time and image volume

Additionally, the third comparing point is checking a visual accuracy of the result.Following images (Figure 6) show how different the visual accuracy of the result image is.

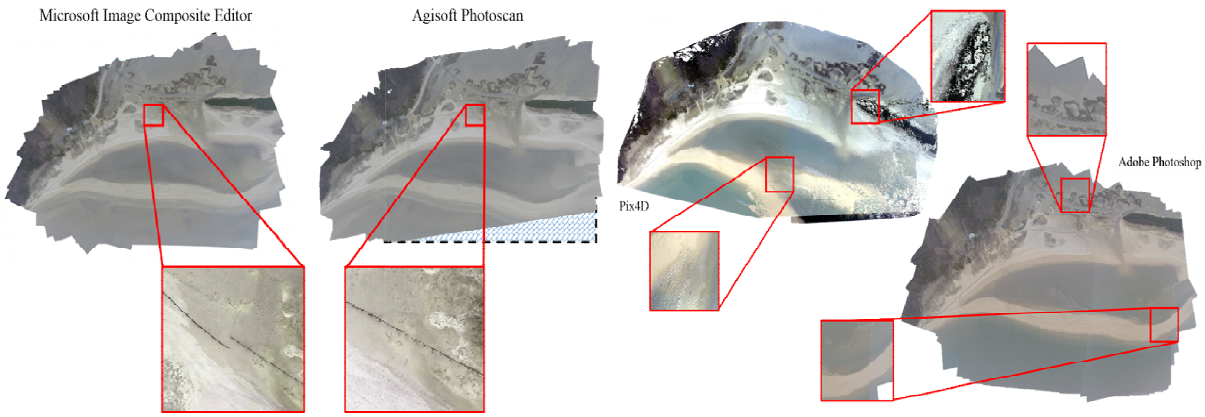

Figure 6. Results of image stitching

The final images of each software show limitations, except Agisoft Photoscan. Microsoft ICE and Adobe Photoshop don't make a smooth surface of the images. There are plenty of distorted connections among the adjacent images. Also, in Photoshop, the color correction does not match well with the other images. This problem can be solved using a vignetting effect, but it takes too much time to calculate. The result image of Pix4D is shoddy

butit may be improved using many stereographic UAS images to cover the entire research area. Photoscan, however, shows the best result: greater visual accuracy and good color correction. Althoughthe processing time and the image volume of itare higher than those of MS ICE, they are lower than those of Pix4D.

4. CONCLUSION

In these days, researchers can easily find alternative open-source softwarethat can save their costrequired for high-cost commercial software. But it is true that some of the open-source software cannot show as good performance as commercial one. Thus, some of the commercial software is suitable for complex and elaborate research work. Therefore, it is valuable to test programs for a specific processing.

One of the famous open-source image stitching software, Hugin, does not show its powerful performance in an academic experiment. Although assuming so many reasons, one of the main reasons is its limitation in calculation; this software is not suitable for complex image stitching.On the other hand, many open-source programs are available especially for image stitching. Visual SFM, for example, became the best 3D image reconstruction open source software. Many researchers use this program rather than buying an expensive commercial program.

The sales market of UAS, called Drone, have been increased geometrically in many countries with cheap price. Many people use this small plane and a camera to capture their neighbor or journey. Therefore, the needs of image stitching will be increased in the near future. For these reasons, the characteristics of open-source programsshould be compared fro public to choose the best program for their specific work.

5. REFERENCE

California Institute of Technology., 2011-last update. Available: http://me2.do/5aNxf3Nc

Jensen, J. R., 2009. *Remote Sensing of the Environment: An Earth Resource Perspective 2/e*. Pearson Education India.

LeBlanc, B., Niezrecki, C.,Avitabile, P.,Chen, J., and Sherwood, J., 2013, Damage detection and full surface characterization of a wind turbine blade using three-dimensional digital image correlation. *Structural Health Monitoring*, 12(5-6), 430-439.

Marshall, D. M., Barnhart, R. K., Shappee, E., and Most, M. T., 2015, *Introduction to unmanned aircraft systems*, CRC Press, New York.

Martinez, R. J., Lahoz, J., Aguilera, D., and Codes, J., 2005, IMAP3D: Low cost photogrammetry for cultural heritage.*Proceedings of the CIPA 2005 XX International Symposium,* Torino, Italy.

Meier, L., Tanskanen, P., Heng, L., Lee, G. H., Fraundorfer, F., and Pollefeys, M., 2012, PIXHAWK: A micro aerial vehicle design for autonomous flight using onboard computer vision.*Autonomous Robots*, 33(1-2), 21-39.

Niethammer, U., James, M. R.,Rothmund, S.,Travelletti, J., and Joswig, M., 2012, UAV-based remote sensing of the Super-Sauze landslide: Evaluation and results, Engineering Geology, 128, 2-11.

Tauro, F., Porfiri, M., and Grimaldi, S., 2014, Orienting the camera and firing lasers to enhance large scale particle image velocimetry for streamflow monitoring, Water Resource Research, 50(9), 7470-7483.

Vierling, L. A., M. Fersdahl, X. Chen, Z. Li, and P. Zimmerman, 2006, The Short Wave Aerostat-Mounted Imager (SWAMI): A novel platform for acquiring remotely sensed data from a tethered balloon, Remote Sens Environ, 103(3), 255-264.

Wójcicka, A., and Wróbel, Z., 2012, The panoramic visualization of metallic materials in macro-and microstructure of surface analysis using microsoft image composite editor (ICE), *Information Technologies in Biomedicine*, Springer Berlin Heidelberg, 358-368.

Zhang, C. and Kovacs, J. M., 2012, The application of small unmanned aerial systems for precision agriculture: a review, *Precision agriculture*, 13(6), 693-712.