Mosaicking Software: A comparison of various software suites

Geosystems Research Institute Report 5071

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3-24-2016

Mosaicking software

Standalone mosaicking software

Three of the major standalone mosaic software packages are Agisoft Photoscan Pro, Pix4D Pix4Dmapper, and SimActive Correlator3D.

Agisoft Photoscan Pro

The primary advantage of Photoscan is its price. It is the cheapest option, and does a sufficient job in most situations. It can take advantage of multiple cores and certain graphics processors to improve performance. Distributed computing, though, requires particular versions of Linux to run correctly. This may cause issues if your particular resources are not configured to handle Photoscan specifically.

The latest version of Photoscan tends to have more problems with problematic imagery than the other two solutions. Whenever there are large stretches of featureless terrain (e.g. water, corn rows), there are no good tie points, and the generated mosaic will have gaps where images could not be correctly projected.

Photoscan is quite fast in producing mosaics, depending on the level of quality desired. It does, however, have a limit on how many images it can handle in a single run, particularly at higher quality settings. These settings will consume large amounts of computing resources, especially RAM. Projects may have to be separated into chunks to process completely, then merged at the end. Agisoft has excellent tools for merging datasets. There is also a limit to how large a single orthomosaic can be, topping out at 4GB (FAT32 limitation). In this case, the data should be exported in tiled format.

The software also has a good color-correction algorithm, which helps the end mosaics look much more like a contiguous single image rather than many stitched-together images.

As far as accuracy is concerned, Agisoft makes no claims about how accurate mosaics are. Observed relative accuracy is quite good, but until recently, Photoscan did not utilize roll, pitch, and yaw for anything other than error estimates, so the absolute accuracy is rather poor. When absolute accuracy is required, it will require using software such as ESRI ArcMap or ERDAS Imagine to manually georectify the mosaic if ground control points are not used. Photoscan does do an excellent job mosaicking imagery that has no GPS information at all. This data can then be orthorectified later.

Photoscan has rather poor point cloud filtering, so some manual culling of points is required. There may also be other data manipulation necessary if the DSMs produced have too many polygons or odd shapes, or other issues arise.

Photoscan does not have a command-line interface, which is not ideal for automated processing. Batch jobs are possible, but all must be done through the graphical user interface (GUI). There is a Python scripting interface, but this too can only be used from inside the GUI. It does, however, boast a user-friendly interface.

Pix4D Pix4Dmapper

Pix4Dmapper is very solid. It seems to handle problematic imagery a bit better than Photoscan. It was able to mosaic some Tetracam ADC Lite imagery that Photoscan could not, although the mosaic produced was rather poor quality. It was recognizable, though, compared to Photoscan's output, which did not produce anything resembling a proper point cloud or orthophoto at all.

Pix4Dmapper is also very fast, like Photoscan, with a simple, easy-to-use interface. It has much better point cloud filtering than Photoscan, which allows for less data manipulation; the data manipulations tools present are excellent when it is needed, though. It also can import boundaries for data and automatically crop mosaics, which is useful should the user not have access to other geospatial software.

It will also perform automatic NDVI calculations, which is very useful for agricultural applications. Like Photoscan, it has very good color-correction algorithms, leading to very natural-looking mosaics.

There are a few drawbacks to the software, in that it requires a decent amount of experience and knowledge to determine the correct parameters for processing different datasets. It also makes very limited use of roll, pitch, and yaw values in mosaic production.

The "Pro" version appears to be a desktop-only application. It does take advantage of multiple cores and certain GPUs. If a scalable solution is required, the "Enterprise" version will be required. It is available for Windows, Mac, and Linux, and also provides a command-line interface for improving workflows. There is also an "Ag" version that can be bundled with a MicaSense Sequoia sensor, which can export NDVI maps and other relevant agricultural products.

SimActive Correlator3D

Correlator3D provides some of the best DSM/DTM algorithms on the market. If precision surveying is a necessity, it is the software to use. The accuracy of Correlator3D, according to the website and in conjunction with their other add-ins, is under a pixel. It gives comprehensive calibration and processing reports for each mosaicking step.

Related to accuracy, Correlator3D fully utilizes roll, pitch, and yaw. This enables one to deal with image sets that give other mosaicking programs issues, such as time-varying scenes (water or wind-blown fields) or scenes lacking detectable, unique tie points. Other programs have difficulty finding tie points within these images, since they do not utilize roll, pitch, and yaw data to project each image onto a surface, leaving large gaps in the mosaic where tie points cannot be found. Correlator3D uses roll, pitch, and yaw values and projects the individual images onto a flat surface, giving a contiguous mosaic even when there are areas for which tie points between images cannot be found. However, Correlator3D doesn't have a very good color-correction algorithm.

Since Correlator3D uses roll, pitch, and yaw information, it can also produce individual orthoimages from each input image. It also will automatically generate overviews for orthomosaics, which is very useful for quicker viewing of the data in other programs like ArcMap or Imagine. In contrast, after Photoscan is finished, overviews of large mosaics must be generated using other programs, such as ArcMap, Imagine, or the freely-available Geospatial Data Abstraction Layer (GDAL) suite of tools.

Correlator3D will take advantage of multiple cores, and can also be configured to utilize certain graphics cards for processing of data. There is also a command-line interface. Parallel computing is done through use of scripting and batch processing, but the ability to use explicit multi-computer/node processing is unknown and may be version or product level dependent.

Unfortunately, Correlator3D can be a bit slow with larger datasets. It also generates a large amount of data, so significant storage may be required for efficient workflows. The interface is not user-friendly, and the software requires some familiarity with scripting and configuration file editing for proper usage.

Other

Trimble Business Center (TBC) is another mosaicking software. It works with data obtained from Trimble's UAS platforms. We have not evaluated the accuracy and effectiveness of the software and the software may only ingest imagery from Trimble's UAVs. Modifications can likely be made to get other aircraft data into the proper format for processing, however, if TBC is already available.

Cloud-based solutions

MicaSense's ATLAS service is used for their lines of multispectral cameras, like the RedEdge and Sequoia. There are very specific procedures that need to be followed to obtain optimal quality from the mosaics. There are some artifacts in the imagery, though, when bright objects are present. We have some speculations as to why this is, based on a response from MicaSense and knowledge of one of our image processing experts. The advantage to their service is that it does the band alignments on the multispectral cameras, and puts together a mosaic and DSM, along with other common products such as NDVI, with very little user input.

This also means that any particular settings when mosaicking, color balancing, reference panel adjustment, and other issues that might need to be controlled for in a research environment are out of the researcher's hands. This can make it more difficult to ensure the data has been prepared as needed, and can also make it more difficult to publish results based on the cloud-based products.

PrecisionHawk also has a cloud-based service called DataMapper. It seems to perform an adequate job in mosaicking imagery, but also gives very little control to the user in what is produced, and very little transparency in how the final products are generated. This is the primary drawback of all the cloud-based systems; there may be quality control on all the imagery, but the end user has no idea what that quality control is.

DroneDeploy has a cloud-based mosaicking software. It is generic in nature, but pricing for the highest tier is $4999/yr, which makes it more feasible to buy a stand-alone software. Of course, this is an option if an institution doesn't have someone that can perform the mosaicking process, and may not have the computing resources and infrastructure necessary. Resolution in their mosaics at this level is claimed to be 1cm/pixel.

Advantages and disadvantages of desktop vs. cloud approach

As alluded to earlier, there are advantages and disadvantages to each approach. For the ordinary user, the cloud-based services are simpler to use, and will provide the necessary information to make timely decisions. It frees them from having to devote computing and storage resources, as often they just want an answer. For example, a farmer might only want a prescription map for fertilizer, or how much to irrigate a particular area of a field.

For research institutions, this may not be sufficient. As there is a significant pressure to publish results, and maintain control over the way mosaics are produced, it is often better to own the software in question and produce mosaics in-house. Most mosaic software isn't very difficult to use when good data is supplied, but it may take a bit more expertise if the data lacks quality. It is much easier to publish when the data is well-known all the way from the raw imagery to the final output.

Pricing

Agisoft Photoscan Pro

Full license for commercial use is $3499, academic use is $549.

Pix4DMapper

Full license for Pix4DMapper is $8700, academic license is $5220.

Correlator3D

Cost of Correlator3D depends on the product level. The full version is $45000. The UAV version is available for organizations that are collecting data with UAS, and has a 40 megapixel limitation for each source image. This version is $5900, and for academic use is $2950.

PrecisionHawk DataMapper

PLAN	STORAGE	PRICE (PER MONTH)
FREE	2GB	$0
BRONZE	60GB	$25
SILVER	200GB	$45
GOLD	500GB	$70
PLATINUM	750GB	$95

MicaSense ATLAS

PLAN	AREA (ACRES/MONTH)	PRICE (PER MONTH)
PER USE	N/A	$0.60/acre ($5 minimum job)
BASIC	150	$50
PLUS	350	$100
PRO	1000	$250

Custom / enterprise plans are also available.

DroneMapper

AREA (KM^2)	GSD > 5 CM	3-5 CM GSD	1-3 CM GSD
< 1	$20	$60	$100
< 2	$40	$120	$200
< 3	$60	$180	$300

DroneDeploy

PLAN	PRICE (MO/YR)	RESOLUTION	PROCESSING TIME	SUPPORT
EXPLORER	Free	20 cm/pixel	Standard	Community-based
PRO	$99/$999	5 cm/pixel	Expedited	Email + Chat
PRECISION	$499/$4999	1 cm/pixel	Immediate	Dedicated ENG support

Custom / enterprise plans are also available.

Summary of desktop software

Agisoft

Pros:

- Fast
- Relatively simple interface
- Easy dataset merging
- Good color-correction algorithm
- Impressive results when processing images without GPS data

Cons:

- Poor point cloud filtering
- Usually requires manual data manipulation
- Only recently has begun to implement roll, pitch, and yaw in camera alignment
- Inefficient hardware utilization

Pix4DMapper

Pros:

- Fast
- Very simple interface
- Extensive documentation and support
- Accurate point cloud filtering
- Excellent data manipulation tools
- Boundary importing and automatic cropping
- Automatic NDVI calculations
- Very good color-correction algorithm

Cons:

- Requires some experience and knowledge to determine proper parameters for different types of data
- Limited use of roll, pitch, and yaw values

Correlator3D

Pros:

- Best DSM/DTM algorithms on the market
- Fully utilizes roll, pitch, and yaw
- Can directly generate georeferenced orthophotos for each image
- Easily processes data over water
- Excellent calibration and processing reports from each processing step
- Automatically builds GeoTIFF overviews

Cons:

- Tends to be slow with large datasets
- Generates large amounts of data
- Requires familiarity with scripting and configuration file editing
- Interface is not user-friendly

- Poor color-correction algorithm