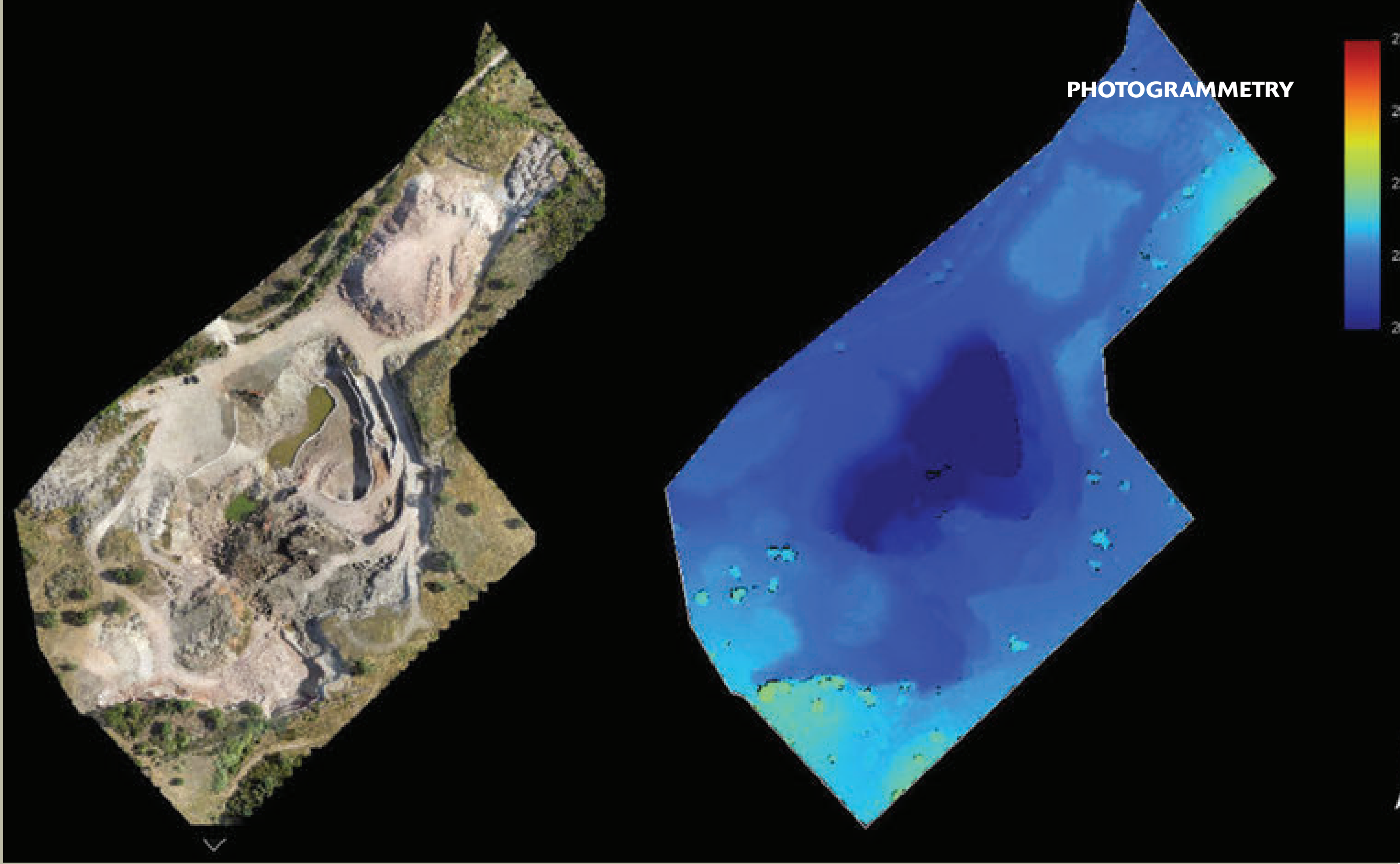


A HYBRID APPROACH TO UAV DATA

DEBORA CALDARELLI DESCRIBES A NEW APPROACH THAT COULD HELP UAV AERIAL PHOTOGRAMMETRY GRAB A SHARE OF THE MARKET

Technological advancements in unmanned aerial vehicle (UAV) manufacture and in post-processing in the past few years have enabled the effective commercial use of UAV for mapping applications. UAV aerial photogrammetry is ready to grab its market share, which has been monopolised by the expensive conventional photogrammetry of manned aircraft for a couple of decades.

The potential challenge in UAV data processing is quality. The quality achieved by conventional photogrammetry systems (manned aircraft with large-format, advanced cameras and stereo processing by an expert photogrammetrist) is very high because of its rigid and tested workflow, which is necessary to provide the high accuracy essential for engineering analysis. In comparison, the data captured from UAVs is post-processed by fully automated software to make it simpler, but this results in decreased accuracy and products because the algorithms used are more general. In many instances, this leads to the data not being authentic and accurate enough for reliable decision-making.

Matrix has designed an innovative workflow after extensive tests and research using the several different sets of UAV data and UAV processing software available. The new workflow overcomes the challenges of UAV data processing in stereo mode and produces results comparable to conventional aerial photogrammetry results in terms of cost, accuracy, time and production efficiency.

The results shows that the new workflow is capable of replacing conventional aerial photography data (which is very costly and sometimes time-consuming) with UAV data (very fast and cost-effective), while achieving the same quality within small to mid-size projects.

Approach

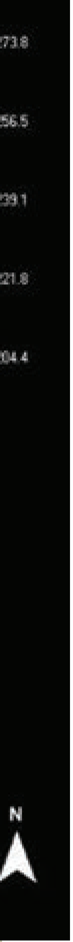
To develop the workflow, the following important processes have been dealt with:

1. Accurate camera calibration.
2. Rigorous bundle block adjustment.
3. Stereo model setup.
4. Stereo photogrammetry – manual 3D data processing.
5. Accuracy assessment.

Accurate camera calibration

For UAV photogrammetry, small-format, non-metric reflex and non-reflex cameras are used due to their lower weight and high resolution. These cameras are very cost-effective if we compare them to conventional aerial-metric cameras and also easily available.

But these armature cameras generally have very high distortions, radiometric problems and issues with small focal length, resulting in rough and difficult photogrammetry. Therefore, accurate camera calibration is extremely important in achieving a high-accuracy result. This process is generally done by using several test photos and software that re-calculates the correct camera parameters, such as focal length, principle point, size of the pixel and image and distortion parameters. Menci Software's Aerial Photo Survey (APS) allows users to automatically extract that camera certificate in a very rigorous way.



Aero triangulation and rigorous bundle block adjustment

This process is crucial to achieving the desired accuracy. It includes setting up the images in the software and tie-point measurement, ground control measurement and finally bundle adjustment to achieve the desired root mean square error (RMSE). APS allows the user to automatically extract tie points using different algorithms and to make a final bundle after ground control point (GCP) collimation.

Stereo model setup

The aero triangulation results generate the parallax-free accurate 3D stereo model on a stereo photogrammetry system that enables the user to view the data in a 3D stereo environment. Before proceeding to further product development and 3D data capture, the aerial triangulation (AT) results are further verified using the original ground controls over the 3D stereo model using Menci's Stereo Tools.

Stereo photogrammetry and 3D manual data processing

Within the 3D stereo environment, the experienced photogrammetrist can verify, delete, create and edit the 3D information. Moreover, he or she can create several 3D products, such as 3D vector data, digital elevation models, manual and semi-automatic contours, and other high-accuracy photogrammetry mapping products.

Accuracy assessment

The UAV data and its product accuracy may be determined by several different methods:
1) RMSE of AT results.
2) Ground control validation over the 3D stereo model.
3) Check for parallax and datum shift in the 3D model.
4) Ground verification of the data derived from UAV data-processing.

The process made with Menci Software APS has been tested on several datasets.

Old versus new

Using a common UAV data processing approach, you can obtain only an auto bundle block adjustment, while using the proposed combined approach (auto and manual), you can also use GCPs.

In the first case, you use a generalised camera type. In the second case, we have a more rigid camera-calibration model to use it further for stereo viewing: no stereo mode is contemplated in the first case, while in the approach that we suggest, we use stereo mode to check/edit/add data in order to achieve the highest possible accuracy.

Figure 1: On the left, automatically processed contours; on the right, contours after manual correction in stereo mode

Figure 2: Corrected DSM and orthophoto based on an accurate DTM

Figure 3: 3D feature extraction

The first approach allows the user to generate an automatic DTM but with bad quality, the low accuracy undermining the orthophoto quality. With the second approach, we can obtain a high accuracy DTM that ensures high quality of orthophoto; the manual editing of DSMs ensures the required accuracy.

The common approach does not allow for 3D-feature extraction – or in most cases, it is very generalized – while with the hybrid approach, plotting the 3D features in a stereo environment ensure high-quality 3D feature extraction.

Finally, the automatic 3D textured model is not of good quality in the first case, while in the second case, using professional software like 3D Studio Max, you can develop the high quality output.

Conclusion

The products derived from the automated method generally depend on the image matching technique, so fail to give authentic results in challenging situations such as obscured, urban or vegetated areas.

The hybrid workflow using 3D stereo mode not only overcomes this limitation but also enables the production of high-quality authentic 3D data products for reliable decision-making. This approach could spark the growth of UAV photogrammetry and its application in various industry sectors.

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