UltraCam-D: A Novel Large Format Digital Aerial Camera from Austria

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Introduction

The time of digital cameras has arrived in aerial mapping. This is reflected by the recent introduction of several digital aerial cameras, and enthusiastic sales reports from their vendors. In Austria, Vexcel Imaging has shown its novel aerial digital UltraCam-D for the first time in April 2003 at the Austrian Geodätentag in Wels, with 90 Mpixels. In contrast to its competitors, the product directly aims to compete with the quality and economy of aerial film cameras by outperforming film achieving a superior economy. After only about 20,000 aerial photos, the digital camera should have been paid for itself simply by avoiding film, photo processing and scanning. But numerous additional advantages exist. We describe the camera, show example images and explain that the time of film is ending in aerial mapping.

Digital Large Format Cameras

The 2000-ISPRS Congress in Amsterdam saw the first announcements of commercial digital aerial cameras by Leica Geosystems with its ADS40 camera and Z/I Imaging with its DMC. In 2003, initial deliveries of actual product systems have been reported and the transition to digital sensing seems to gain momentum. Yet, these new digital cameras seem to not be able to really compete with traditional film cameras. This is mostly because of the questionable economy of the new systems at acquisition costs well beyond € 1million and the associated support and maintenance expenses, and also because of the uncertainty of relying on traditional work-flows.

The need for a one-on-one replacement of the aerial film camera remained an unsolved issue, until the announcement in Aril 2003 of the introduction of the UltraCam-D large format digital aerial camera.

UltraCam-D

The design of this new UltraCam-system was directly aimed at replacing the need for film cameras. To succeed, four very important goals were identified:

- First were system specifications that surpass those of the film camera.
- Second was to produce “photogrammetrically accurate” images with a reliable interior orientation and a high geometry of $\pm$ 2 μm, commensurate with the expectations of traditional photogrammetry.
- Third was the need to produce data that feed into existing photogrammetric work-flows for aerial triangulation, stereo matching and DEM creation, linear vector data collection and ortho-photography.
- Fourth was the achievement of costs so that the system acquisition would finance itself within a short period by savings in film, photo processing and scanning.

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The resulting product meets these requirements. Figure 1 shows the camera system and Table 1 summarizes some of the most important specifications.

Digital versus Film: A Comparison

A first concern of anyone considering a digital camera system is the absence of any hardcopy: no film, no addition to the roll film archive! Yet the case for digital imagery is compelling. The quality of digital images with 12 bits per pixel and color channel produces imagery never before available in aerial mapping, where in the past one had to be satisfied with the notorious 7-8 bits per scanned pixel. In our scanner business, we have even encountered film imagery with only 11 gray values (= 3.5 bits). Figure 2 illustrates the case with a comparison between film (scanned at 15 μm) and a digitally sensed image. The grain noise is gone, the contrast is larger, both bright areas as well as shadows get resolved, interpretability is improved. The net effect on the user is the ability to fly higher and produce fewer data than one would have collected with traditional systems, or to enjoy the increased quality for its result on the accuracy and legibility of the image products.

The radiometric advantages also propagate through the stereo process. Stereo matching is often 2.5 times better with smaller matching errors and a lack of blunders. Manual work to support DEM-creation is greatly reduced.

Another appeal is due to the simultaneous collection of true RGB- and false-color with Near Infrared, while also collecting panchromatic images in the same system.

The ease of a fully digital workflow is reflected in the ability to check the quality of the collected imagery while still in the air, and the shortened time between image collection and processing the data through the photogrammetric office system.

Most compelling is the avoidance of all expenses for film, for photo processing and for any scanning. In many instances these costs are at € 20 per color photo, depending on local circumstances. This absence of film costs results in a self-financing ability for the investment into the new technology with a mere 20,000 photos.

So how can we make a transition to digital sensing and cope with the absence of a hard copy archive?

From Film to Digital Pixels?

Digital images have been used in every-day photogrammetric production since about 1990. Yet this has not resulted in a transition from film to digital data. The long term stored imagery is still on film, resulting in an ever-growing archive of roll film, at times also of boxes full with cut film sheets. In many instances, the scans will be deleted after their use, since film is the preferred medium. The transition to the digital world has therefore not yet been accepted in aerial mapping. The digital camera will change this.

The internet-enabled long-term digital picture archives and catalogs are assuming the role of the film archive. Satellite remote sensing has never really considered film, so the archiving and cataloging systems were digital from the start. Data aging, a serious issue with film, is also an issue with digital data. Such digital sources need to be duplicated and copied to maintain data legibility across decennia.

This evolution will also affect the role of traditional film archives that now can be converted to digital formats and loaded into a digital archive.

Paradigm Shift?

The absence of film costs offers the potential far a “killer advantage” of digital sensing: collecting images at very high forward overlaps. Instead of using the minimum number of images for a project, one uses as many images as is useful, thereby maximizing the overall project costs, mostly reducing manual labor. This may represent a major paradigm shift in photogrammetry. Fully automated production becomes a reality, when each terrain point is not only shown on 2 images, but on 10 or 20. Procedures will become very robust, blunders become a thing of the past, and accuracy values increase.

Conclusions

Consumer as well as professional photography are rapidly converting to digital cameras. Aerial mapping will now follow. The advantages are too large to ignore. The competitive disadvantage of film is too distinct to hold out against the beginning acceptance of aerial digital sensors.

What is starting off as a modest change in sensor technology has the potential of leading to an entire paradigm shift. Highly redundant aerial sensing becomes feasible, and it can lead to a vastly improved automation of all photogrammetric procedures.

Figure1: UltraCamD large format digital aerial camera with sensor unit (left), storage and computing unit (center) and the visual interface (right) as the on-board elements of the system. The storage and computing unit optionally can serve as the „ground processing work station“.

Table 1: Specifications of the UltraCam-D

Sensing Unit	
Panchromatic image format	11500 * 7500 pixel @ 9 µm, 103.5 mm * 67.5 mm
Lens system focal distance and aperture	100 mm, f 1/5.6
Field of view cross/along track	55° / 37°
Multi-spectral (RGB, NIR)	4,008 * 2,672 pixel, @ 9 µm
Shutter, seconds	1/500 – 1/60
FMC	TDI controlled
Frame rate	1.3 frames / second
Radiometric resolution	> 12 bit
Dimensions	45 cm * 45 cm * 60 cm
Weight	< 30 kg
Storage & Computing Unit	
Storage Capacity	> 1 TB
Uncompressed Frames	> 2725 frames
Dimensions	55 cm * 40 cm * 65 cm
Weight	< 35 kg

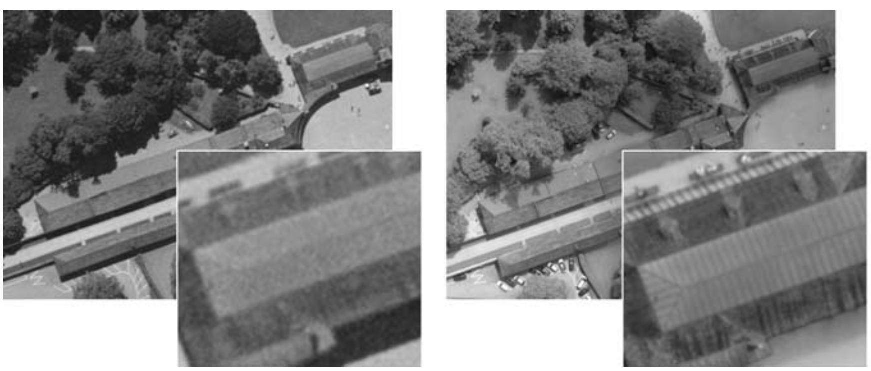

Figure 2: Comparing aerial film (left) and digital imagery (right) with a ground sampling distance of about 15 cm. Note how the absence of grain noise and better radiometric range in the digital image provide better interpretability.