ULTRACAM EAGLE, RESULTS FROM CALIBRATION AND TESTFLIGHTS

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ABSTRACT

We present results from the calibration and flight missions with UltraCam Eagle. This new camera was introduced into the market in May 2011 at the ASPRS in Milwaukee, WI. The new flagship product of Microsoft/Vexcel Imaging offers a very large image format at a total size of 260 Megapixels and thus an enhanced productivity in the air. The calibration of the camera and the proof of the geometric and radiometric performance are described in detail and show the potential of this sensor.

KEYWORDS: UltraCam, digital camera, remote sensing, digital photogrammetry, calibration

INTRODUCTION

Since the first digital aerial mapping cameras came to the market, a constant increase of frame size and increase of the amount of pixel across the flight strip took place. That development was driven by the need of flight efficiency to minimize flight costs, minimize flying time and to minimize project risk. The key parameter for this efficiency of a digital aerial camera is the number of pixel across flight strip. The number of pixels along the flight line has minor impact on the collection efficiency. Since Vexcel Imaging offers the UltraCam digital aerial camera system this collection efficiency was always in the focus of the development. Thus Vexcel was able to increase the frame size of the UltraCam Sensor head from the 86 MPix UltraCam D (11500 Pix cross track) to the 136 MPix UltraCamX, the 196 MPix UltraCam Xp and now the 260 MPix UltraCam Eagle with 20010 Pixel frame size cross track (cf. Figure1and Figure2).

Figure 1: UltraCam Eagle digital aerial frame camera. Sensor Head, Interface Panel, Office Power Supply, Docking Station and SSD On Board Storage Component.

This large format camera offers a collection efficiency of +70% compared to the UltraCam D and enables the user to collect project areas at lower flight time and flying costs. The camera was introduced into the market in May 2011 during the ASPRS congress in Milwaukee, WI.

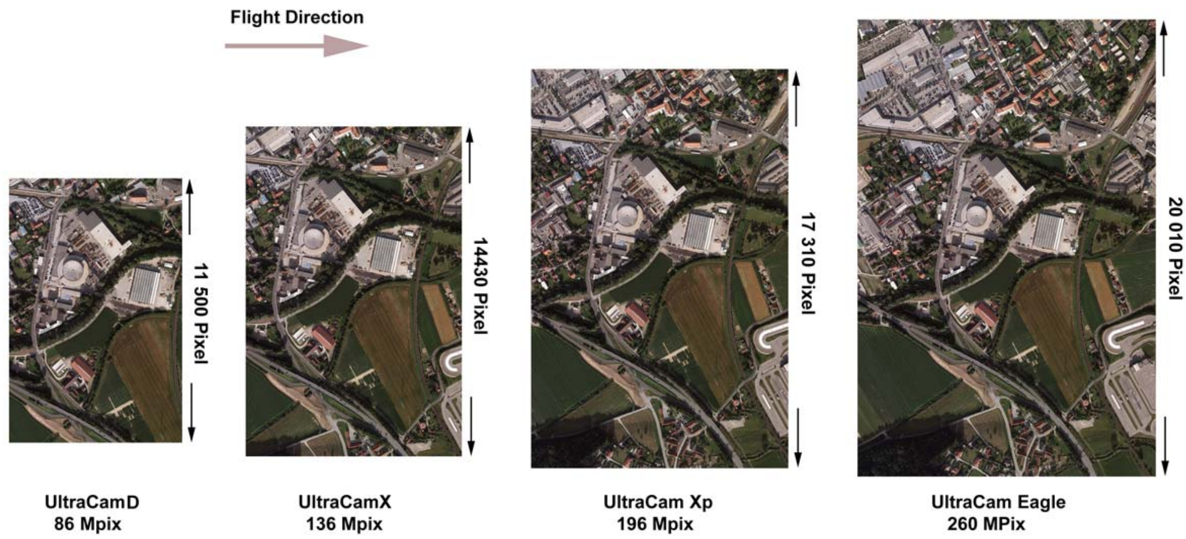

Figure 2: UltraCam frame format: From left to right UltraCam D, UltraCam X, UltraCam Xp and UltraCam Eagle offering 11.500 Pixel (UltraCam D) to 20010 Pixels (UltraCam Eagle) cross track.

THE ULTRACAM DESIGN CONCEPT

The photogrammetric design concept of the UltraCam Sensor Family is based on four camera heads for the large panchromatic frame and four additional camera heads for multi spectral sensing (red, green, blue and near infrared). The basic idea was introduced in (Leberl et al., 2003) shows a 4 cone concept for the large format panchromatic image. Even when the hardware design basics did not change over the years the software to post process images was continuously improved. The outcome of that software development are a smooth workflow and high quality production images from a robust and accurate post processing namely the so called “Monolitic Stitching” which was introduced in 2010 (Ladstädter et al., 2010).

ULTRACAM EAGLE – WHAT’S NEW

The new UltraCam Eagle offers a number of new features and therefore is a radical new camera system. Each component has been rigorously reviewed and newly developed to the extent of today’s technological limits. The camera has new electronics for a fast frame rate of < 1.80 seconds, a new storage system and a new camera flexible modular housing concept. The newly developed optical system has an 80 mm focal distance for PAN and 27 mm focal distance for RGB/NIR. A set of 210 mm and 70 mm for high altitude large scale missions is in preparation. The lens design enables the camera to resolve the new CCD sensor arrays with a pixel size of 5.2 μm. More details may be found in (Wiechert et al, 2011).

Key parameters of the UltraCam Eagle are listed in Table 1.

Panchromatic image size: 20,010 x 13,080 pixels
Panchromatic physical pixel size: 5.2 µm
Input data quantity per image: 842 megabytes, 260 megapixels
Lens system 1: 80 mm PAN and 27 mm RGBNIR
Lens system 2: 210 mm PAN and 70 mm RGBNIR, exchangeable by a trained end user, no recalibration required
Maximum frame rate <1.8 seconds per frame
CCD signal to noise ratio: 72 dB
CCD image dynamic: 14 bit; workflow dynamic: 16 bit
Physical dimensions with 80 mm (210 mm) PAN lenses, including computer and storage module: 43 cm x 43 cm x 76 cm (86 cm)
Weight with 80 mm (210 mm) PAN lenses, including computer and storage module: approximately 75 kg (80 kg)
Power consumption at full performance, including computer and storage module: 350 watts
Solid-state disc pack, with optional storing of mirror images of the data on the data unit
Unlimited with use of multiple data units with approximately 3.3 terabytes (3,800 images) per unit
Data recording time @ 10 cm GSD, 60 percent forward overlap, 140 kts @ 8 hours per data unit
Maximum forward overlap @ 10 cm GSD (@ 5 cm GSD) with 140 kts @ 90 percent (80 percent)

Table 1: UltraCam Eagle Features and Technical Details

Geometric Performance

The geometric performance of the UltraCam Eagle was analyzed by means of a least squares bundle adjustment of a block of images. We report about a flight mission which was carried out in the area of the city of Salzburg, Austria on 29 November 2011. The block consists of 199 images, 4 flight lines North-South and 3 flight lines East-West. The flying altitude was about 1950 m ASL, thus an image scale of 1 / 24000 and a GSD of about 12.5 cm was achieved. The overlap was set to 80% / 60%. Thus the redundancy of the adjustment was high and the result of the data can be well accepted to reflect the quality of the camera (cf. Figure 3). Of interest was the analysis of remaining image residuals which could be identified at a magnitude of less than 1 µm in 260 1k by1k Pixel image cells (cf. Figure 4).

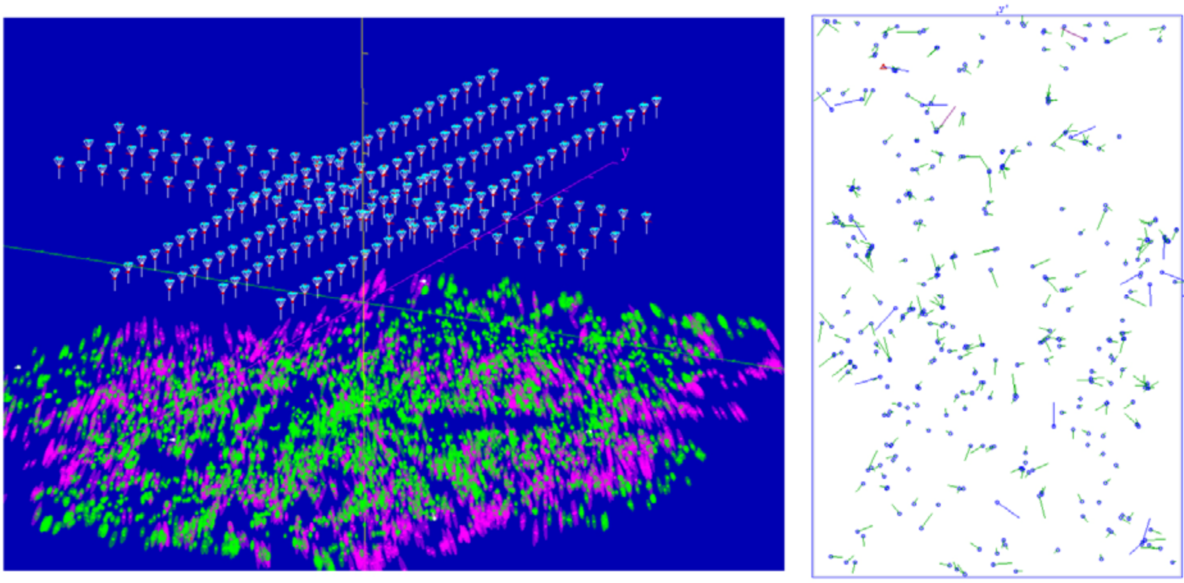

Figure 3: Aero-triangulation project from 199 UltraCam Eagle photos. The block layout shows the high overlap and cross strips (left). The maximum image residuals of frame 165 are well below 1 Pixel (right).

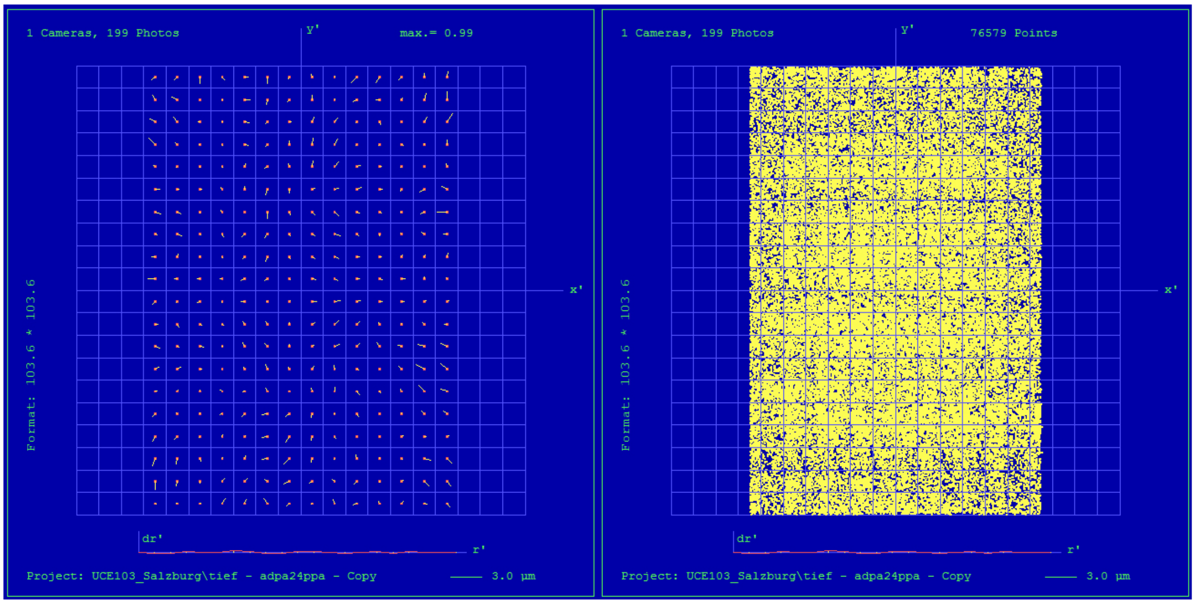

Figure 4: Results from the bundle adjustment: The systematic image residuals are below 1 µm (left). The entire number of image positions measured is 76579 from 8706 object points.

Radiometric performance

UltraCam Eagel is equipped with completely new electronic components which are tailored to manage the new CCD sensor array and to allow high quality read out and convert to digital of the analog signal. The dynamic bandwidth and the small remaining noise have been investigated. A very high quality within the result could be identified. By the use of a single frame of UltraCam Eagle we demonstrate the inter scene dynamics and analyze the digital data (cf. Figure 5).

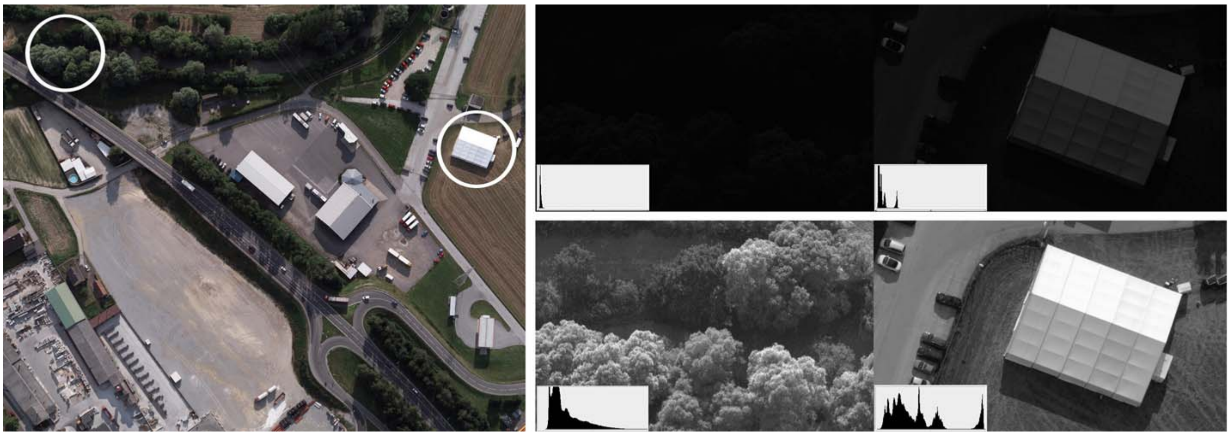

Figure 5: The radiometric performance of the camera is illustrated by investigating the dynamic range of one single frame. Dark and bright object details are identified (left) and the local image content is analyzed (16 bit linear and 16 bit enhanced, upper right and lower right). The maximum within the bright roof was found at 12416 DN.

CONCLUSIONS

The new UltraCam Eagle digital aerial sensor was successfully introduced into the market. The radiometric and geometric performance of the camera is at a very high quality level and enables the user to be productive, and produce high quality photogrammetry results. As already mentioned the camera is based on Vexcel's concept of "Software Leveraged Hardware". The advantage of this mature technology is well proven and accepted in the community.

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