

ULTRACAMXP, THE NEW DIGITAL AERIAL CAMERA SYSTEM BY VEXCEL IMAGING / MICROSOFT

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ABSTRACT

At the ISPRS Conference in Beijing 2008 Vexcel Imaging/Microsoft Photogrammetry presented the new flagship product - the large format digital aerial camera UltraCamXp. In this paper we give a detailed description of the new camera and present first results from photo flights. The design principles of the camera are comparable to those of the predecessor model, the UltraCamX. Updates on the parameters are lined out and the performance of the new camera is presented. In addition to the large format the medium format camera UltraCamL was introduced at the ISPRS conference. A short description of this camera is given in this contribution.

KEY WORDS: Photogrammetry, Digital, Camera, Large Format

INTRODUCTION

UltraCamXp was introduced into the international mapping market in July 2008 in Beijing. The large format digital aerial frame camera is based on the design concept of the well known UltraCamX. The most valuable advantage of the new sensor is the larger image format and therefore an enhanced productivity.

The 17310 pixels cross track and the 11310 pixels in flight direction define the 195 Megapixel frame size. Still fast the camera is able to produce images at 3 cm GSD with 60% overlap and at a speed of 130 kn.

The sensor unit is based on Vexcel's well known multi cone design concept (Gruber, 2007). This concept was actually presented in 2003 together with the UltraCamD camera system (Leberl et al., 2003).



Figure 1. Sensor Unit (left) and onboard storage components of UltraCamXp digital aerial camera system. The removable data units offers each a capacity of 6600 images or 4 TeraByte.

Camera Design and Parameters

UltraCamXp is a digital large format frame camera. The photogrammetric workflow which is supported by UltraCam images is well known. Nevertheless for optimization knowledge about camera details are necessary. In this paper we present such information.

The most important parameters of the UltraCamXp camera system are listed below:

- Large image format of 17310 pixels cross track and 11310 pixels along track enabled by new 6 μm CCD Sensors (the DALSA FTF 6040 M CCD sensor product)
- Physical image size of 104 mm by 68 mm
- Proven optical system with 100 mm focal length for the panchromatic camera heads and 33 mm for the multi spectral camera heads
- Image storage capacity of 6600 frames for one single data storage unit
- Instant data download from the airplane by removable data storage units
- Fast data transfer to the post processing system by the new docking station

The camera consists of the sensor unit (see Fig. 1, left), the onboard storage and data capture system (see Fig. 1, right), the operators interface panel and two removable data storage units. The Camera Operating System (COS), V3.2 is the well accepted software to operate the camera in the air. The new UltraMap Platform offers a comfortable and powerful workflow for post processing the images. The image format of the new sensor UltraCamXp (195 MPix) has more than twice as many pixels as the UltraCamD (86 MPix). This development of the image format was achieved within 5 years from 2003 to 2008. It is remarkable, that the storage capacity of the HDDs of the storage units of the system did develop much faster from 60 GByte to 320 GByte.



Figure 2. The UltraCam large format camera evolution: from left to right UltraCam D (2003), UltraCam X (2006) and UltraCam Xp (2008). The image format improved by a factor of 2.3, the storage capacity improved by a factor of 5.3 within a period of 5 years.

Software Components

The entire system consists of hardware components as well as software tools to operate the camera in the air and to process images after the flight mission. The well known Camera Operating System COS was optimized during the last years and was adapted for UltraCamXp and the larger image format of the new camera. The post

processing software OPC (Office Processing System) is currently being replaced by the new UltraMap Platform. This software system will contain the well known functionality of the post processing tool OPC but will also offer new and powerful functions.

Noteworthy is the UltraMap visualization engine Dragonfly, based on Microsoft Seadragon technology. It is designed to ease the handling of the large amount of thousands of UltraCam image data by using tiled image pyramids and graphics card acceleration. This allows fast access to multi-resolution image data. During visualization, the required information is retrieved from the according images and is used for fast display. The high dynamic range of the UltraCam image data (> 12 bit) is fully supported by this approach.

UltraMap supports various visualization modes:

- The footprint view shows the image outline projected down to the ground level using the available GPS and/or IMU data.
- Indexmap view shows a block of geo-located images.
- Heatmap view is a visualization type for showing the degree of overlap of the image block. The color-coded regions allow immediate visual recognition of flight patterns.
- Thumbnail view allows a more semantic image clustering. For instance, images may be grouped by their strip number or histogram statistics.
- The overlay concept is designed for visualizing additional meta information on top of image data. This may include image IDs as text, footprints, projection center, ground control points, tie points, and so forth.

The aero-triangulation component UltraMap AT does offer the interactive point measurement functions, which exploit the image display capabilities of Dragonfly as well as an automated multi tie point processor. This component makes use of the concepts of modern digital photogrammetry, namely multiple overlaps, robust blunder detection and high dynamic range of image data (Gruber et. al., 2003). The large number of initial tie points are filtered through a robust and iterative selection process, were quality measures from the image matching as well as results from the bundle solution are consequently merged. The final bundle adjustment solution is computed by the well known BINGO software product (Kruck, 1984).

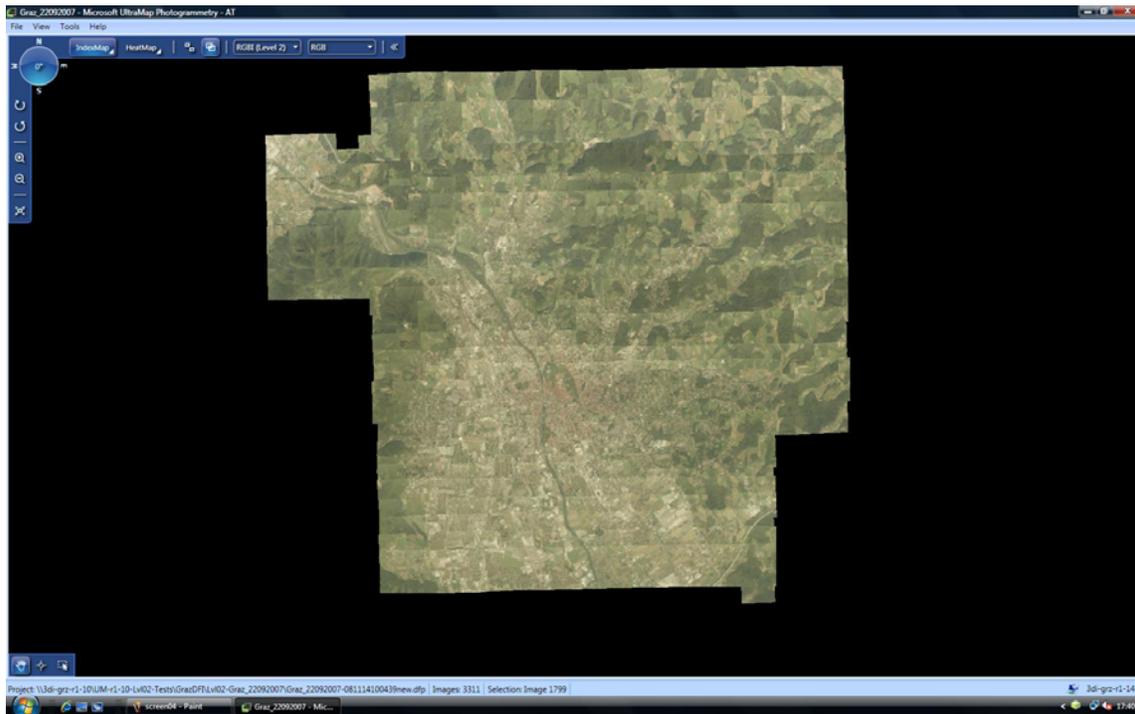


Figure 3. The UltraMap – Dragonfly GUI enables the operator to control large amounts of image data. This block of 3300 UltraCamX images consists of 428 GPixel or 2.5 TeraByte of digital Data.

ULTRACAMXP FLIGHT MISSION

The UltraCamXp camera system is in operation since July 2008. In this contribution we present results from a large scale photo mission. The entire flight consists of 99 images taken from an altitude of 500 m above ground level. The base length at 60% endlap was set at 135 m. The speed over ground was 60 m/sec (117 kn). The frame interval of 2.25 sec as well as the forward motion compensation (FMC) of 6 pixels at 3 msec could easily be achieved by UltraCamXp. The flight was processed and triangulated and did show quite remarkable results after the least squares adjustment. The σ_o of the block was achieved at $0.87 \mu\text{m}$ ($\sim 1/7$ Pixel) without self calibration parameters. RMS control point residuals were computed at a 2.5 cm for x/y as well as for z ($= 0.05$ o/oo of the flying height).



Figure 4. 800 by 500 Pixels (~ 24 m by 15 m) subarea of frame 0086 taken on Oct-29-2008 from an altitude of 500 m above ground level. The footprint size of one full frame is 520 m by 340 m.

Like all UltraCam sensors the UltraCamXp is tested through a flight mission over the well known test area of Gleisdorf near Graz (Gruber, Ladstädter 2008). The mission from September 23rd, 2008 shows the geometric performance of UltraCamXp. A GSD of 10 cm was achieved from a flying height of 1670 m above ground level within 413 photos. The σ_o of $0.93 \mu\text{m}$ is beyond the $1 \mu\text{m}$ magnitude. The RMS residuals of the 40 GCPs are 31 mm, 32 mm and 48 mm for X, Y and Z (this corresponds to 0.028 o/oo of the flying height). Image distortions were detected at $1.1 \mu\text{m}$ without self calibration parameters and at a magnitude of $0.44 \mu\text{m}$ after self calibration parameters were introduced into the bundle adjustment.



Figure 5. 700 by 500 Pixels (~21 m by 15 m) subarea of frame 0086, panchromatic channel.

The range of grey values (DNs) is above 5000 (=12.4 bit).

The color bands of the same area show a dynamic range between 11 bit and 12 bit.

The radiometric performance of the new sensors at $6\ \mu\text{m}$ by $6\ \mu\text{m}$ pixel size is still at the 12 bit level. This is illustrated in Fig. 5, where a part of the panchromatic channel of frame 0086 of the mentioned flight mission was analyzed. The façade of the building was under bright sunlight and contains pixels with digital values of 5717 and 498.

The dynamic range of the four color bands of that small image area does show similar quality. The blue channel shows only 11.0 bit, red contains 12.0 bit, green 11.9 bit and near infrared 11.5 bit of radiometric information. The noise was measured at a level of 1.15 to 1.36 bit. The brightest areas of the image still show values beyond 7000 DN.

VEXCEL'S PRODUCT PORTFOLIO

It is noteworthy, that Vexcel Imaging GmbH under the ownership of Microsoft Corp. did proceed on its way developing and offering new and innovative products. After the series of 3 large format digital aerial cameras UltraCam D (presented in 2003), UltraCam X (presented in 2006) and UltraCam Xp (presented in 2008) Vexcel proudly presented its new medium format . This new camera named UltraCam L was presented at the show-floor of the ISPRS conference in Beijing in July 2008. The sensor is designed as the high precision medium format mapping camera and shall enable smaller companies to enter into the digital era at a very attractive price as well as offer a flexible production camera in a smaller aircraft just for smaller projects. The camera will provide a high quality panchromatic image at 9735 by 6588 pixels.

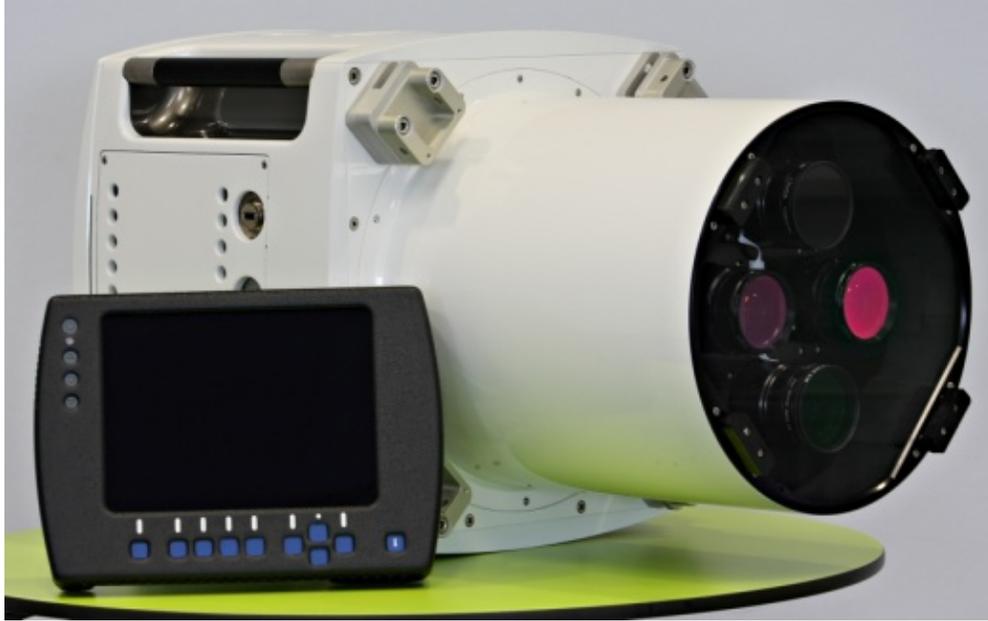


Figure 6. The new UltraCamL metric camera offers a new concept of medium format metric camera design.

CONCLUSIONS

The digital aerial camera UltraCamXp did have a successful start into the mapping market. Based on the predecessor camera UltraCamD and UltraCamX it is the new flagship product of Vexcel Imaging GmbH / Microsoft Photogrammetry. Larger image format and therefore enhanced performance in the air is combined with improved storage capacity and excellent performance in both, geometry and radiometry. Together with new software components and products and the new UltraCamL medium format mapping camera the product portfolio of Vexcel Imaging shows a significant development.

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