NEWS FROM THE ULTRACAM CAMERA LINE-UP

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ABSTRACT

This paper presents the latest news from Microsoft's UltraCam camera line-up, namely the new sensor system called UltraCam Falcon and the new lens options available for the UltraCam Eagle.

KEY WORDS: Photogrammetry, Digital Camera, Large Format, UltraCam, MIcrosoft

INTRODUCTION

With the presentation of the ultra-large format camera UltraCam Eagle at the ASPRS 2011 conference in Milwaukee Microsoft/Vexcel Imaging opened a new basket in the digital aerial camera product portfolio. The 260 Mega Pixel frame size of the Eagle and its 20,010 Pixel cross track image format did answer the on-going need for higher productivity in the air and the reduction of flying costs. Figure 1 shows the camera system including the sensor head with the interface panel and SSD storage module. The docking station and the office power supply are used for data download and operation outside the aircraft and are part of the package.

Figure 1: Ultra-large format UltraCam Eagle. Sensor Head, Interface Panel, Office Power Supply, Docking Station and SSD On Board Storage Component.

The UltraCam Eagle is the flagship and the first sensor based on the newly developed so called 3rd generation UltraCam architecture. This 3rd generation architecture offers a number of innovative design solutions to the customer such as:

- Newly developed proprietary lenses
- New proprietary camera electronic for even faster frame rate
- Even further improved image dynamic due to the new electronic

- Integrated computers
- Integrated solid state storage
- Integrated UltraNav (GPS/INS/FMS system)
- Reduced size, weight, and power consumption
- Multiple camera configurations
- Exchangeable lens systems (UltraCam Eagle only) by the introduction of a new precision mount system for the camera lenses

CAMERA LINE-UP

Figure 2 shows the current UltraCam camera lineup, consisting of UltraCam-Lp (left), UltraCam Falcon (middle) and UltraCam Eagle (right).

Figure 2: Current UltraCam camera line-up: UltraCam-Lp (left), UltraCam Falcon (middle), UltraCam Eagle (right).

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This line-up has been developed based on an innovative roadmap of products since the announcement of the UltraCam-D in 2003. Figure 3 shows the roadmap of the camera line-up since 2003 and the contributions to the 3rd generation architecture:

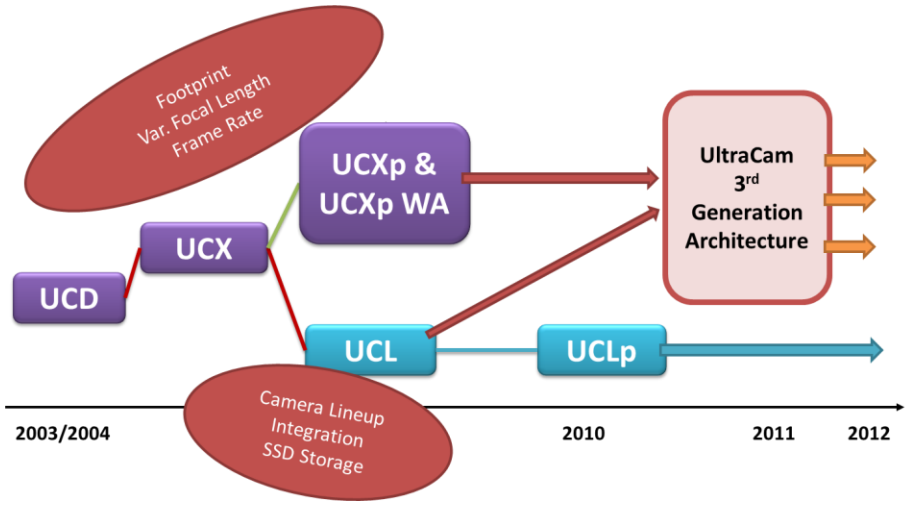
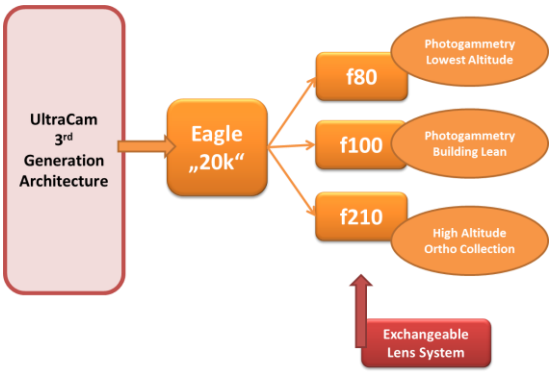


Figure 3: UltraCam product roadmap.

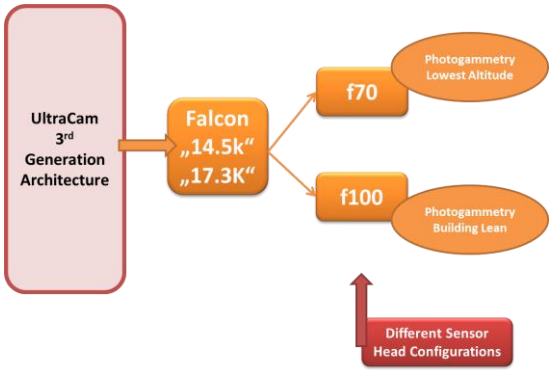
The first camera based on the 3rd UltraCam architecture is the UltraCam Eagle, released in 2011, featuring a footprint across strip of 20,010 pixels and a frame rate of 1.8 seconds per frame. The UltraCam Eagle also features an exchangeable lens system. Currently three different lens configurations are available:

- 80mm PAN focal length for photogrammetric applications when lowest possible flight altitude is required
- 100mm PAN focal length for photogrammetric applications when lean at the image edges is a determining criteria
- 210mm PAN focal length for high altitude ortho image collection when collection of high resolution images of highest quality from high flight altitudes is required



The next sensor system based on the 3rd generation architecture is the UltraCam Falcon series, released in autumn 2012. The Falcon series features a footprint across strip of 14,310/17,310 pixels and a frame rate of 1.2/1.5 seconds. The UltraCam Falcon is available with four different sensor head configurations:

- 70mm PAN focal length for photogrammetric applications when lowest possible flight altitude is required
- 100mm PAN focal length for photogrammetric applications when lean at the image edges is a determining criteria
- Both configurations are available with 14,310 or 17,310 pixels across flight strip



The UltraCam-Lp continues to be the entry into the UltraCam camera line-up with a productivity of 12,000 pixels across the flight strip and a frame rate of 2.0 seconds per frame. It comes with a 70mm PAN focal length and has also an integrated computer and storage system.

ULTRACAM FALCON

As already discussed, the UltraCam Falcon is the second camera system based on the 3rd generation architecture. The Falcon represents the successor of the UltraCam X and Xp series from which the basic camera parameters are derived from.

The Falcon utilize the proprietary Dalsa CCDs FTF 6040 and FTF 5033 @ 6 µm and 7,2 µm technology and the proprietary 70mm and 100mm lens systems, adopted to the new architecture.

Camera architecture, electronic, storage and computing components and integrated system components are based on the 3rd generation architecture like the UltraCam Eagle.

Figure 3 shows a sample image taken by the UltraCam Falcon, demonstrating the excellent image quality, especially contract, radiometry and sharpness.

Figure 3: UltraCam Falcon sample image. GSD = 7.5cm

ULTRACAM EAGLE - HIGH ALTITUDE ORTHO MAPPING

With the introduction of the 210mm lens system for the UltraCam Eagle, the application of the UltraCam is extended into the so called high altitude ortho mapping application. The demand for high resolution images taken from higher flight altitudes is increasing. Often due to flight restrictions over cities, a collection from lower flight altitude is not possible. That is a breakthrough for this type of application as finally the legendary geometric accuracy and radiometric performance of the UltraCam is now also available in this segment.

The images on the right show the UltraCam Eagle with the cone extension for the 210mm lens system and a look from underneath showing the new telescopic lens system.

Figure 4 shows the flight altitudes for a 5cm GSD image by examples of various configurations of UltraCam cameras:

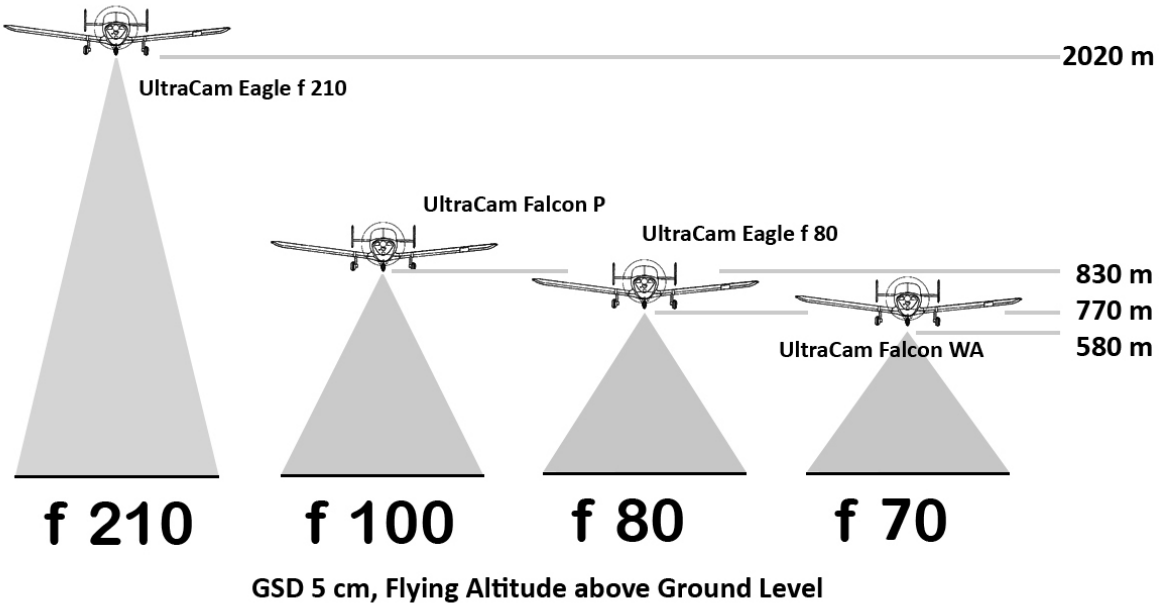


Figure 4: Flight altitude comparison for several UltraCam cameras, image GSD = 5 cm.

First test flights performed with the UltraCam Eagle with the 210mm lens system showed excellent results for AT and also for Dense Matching thanks to the high resolution PAN channel, not suffering from any interpolation such as Bayer pattern based sensors. The small field of view of the 210mm lens system minimizes building lean for tall buildings and occlusions are minimal even for narrow streets or alleys. That allows full utilization of the 20,010 pixel swath width for ortho image production and only minimal flight strip sidelap is required to collect a very consistent looking block.

Additionally, the flights demonstrated that the excellent image quality of the UltraCam is also achieved with the 210mm lens system.

High altitude image collection has specific challenges such as the loss of contrast and color shifts caused by the atmosphere. Whilst Bayer pattern based cameras do not have enough radiometric dynamic, with the UltraCam Eagle it is possible to restore the image quality during post-processing.

We have used the Gleisdorf test area near Graz, Austria in order to analyze the geometric performance of the UltraCam Eagle with the 210mm lens system by means of a least squares bundle adjustment of a block of images. The block from Oct-17-2012 consists of 597 images, 9 flight lines North-South and 5 flight lines East-West. The flying altitude was about 2020 m AGL, thus a GSD of about 5 cm was achieved. The overlap was high at 80%/60% in order to achieve high redundancy. (cf. Figure 5).

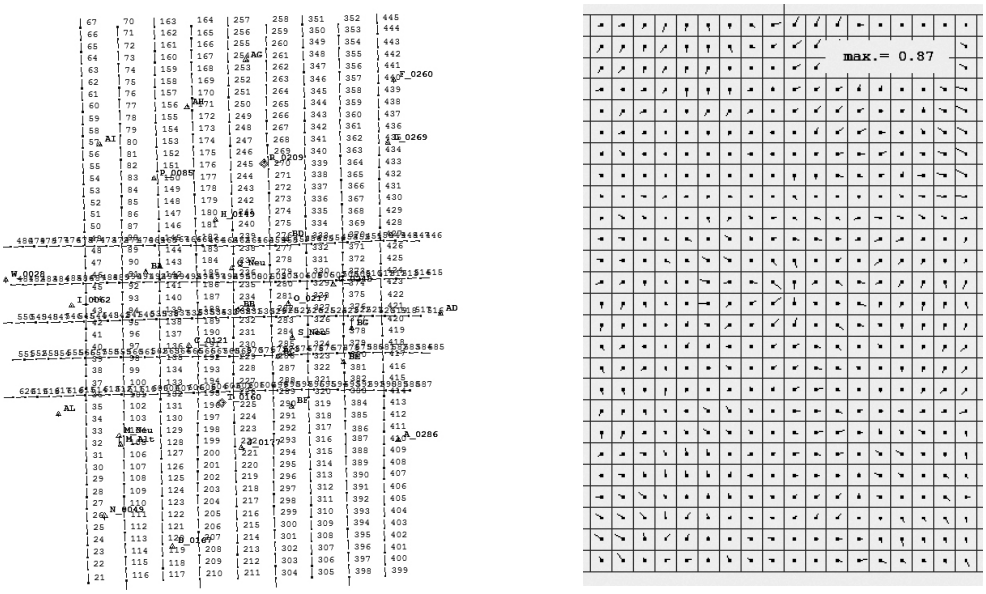


Figure 5: Aero-triangulation project from 597 UltraCam Eagle photos. The block layout shows high overlaps and cross strips (left). Image residuals after the least squares adjustment are illustrated on the right.

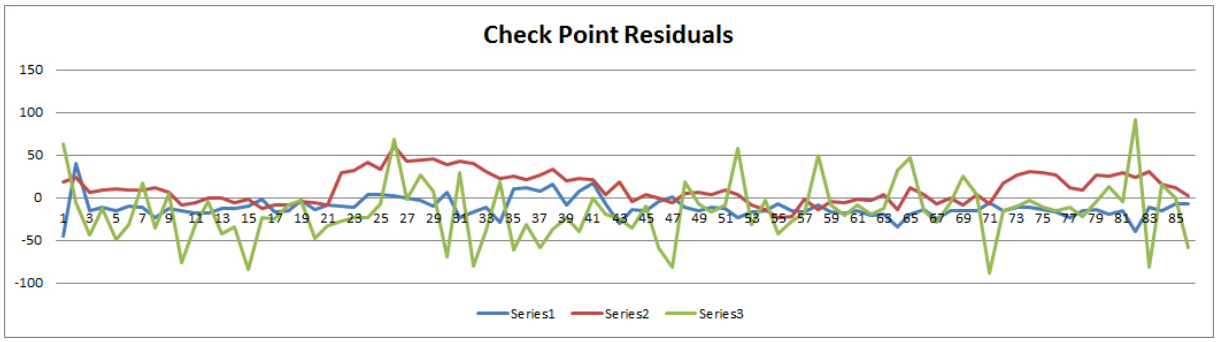
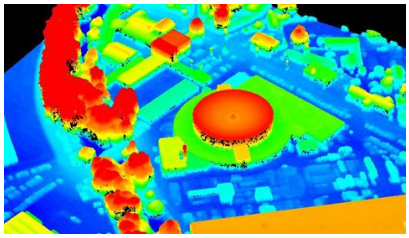


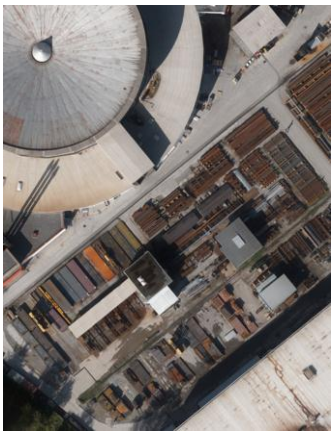
Figure 6: The photo mission was supported by GPS and IMU. The residuals at ground control points and check points did show the high geometric quality of the camera with the 210mm lens system. Root mean square residuals were recognized at the 1/2 to 1 GSD level.

Despite the long focal length and the resulting lower base/height ratio, the results of the aero triangulation are excellent. This supports the fact that an excellent radiometry supports also geometry due to a clearer differentiation and higher amount of details visible in the image.



Also the results achieved with the Dense Matcher of UltraCam are excellent. That makes the data set very versatile.

The image series below show a sample image taken by the UltraCam Eagle f210. GSD is 5cm. Images have been taken from a flight altitude of 2020m.



The images show the excellence radiometry of the UltraCam Eagle with the 210mm lens system. Also the images are remarkably sharp. Thanks to the radiometry of >12 bits, the impact of the atmosphere such as color shifts has been corrected during post-processing perfectly.

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